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THE TRADITIONAL EXAMINATION.[1]

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What do we mean by the traditional examination? It is the final examination. In some cases the pupil's paper is not even returned to him, in the majority of cases the pupil never consults the teacher after this examination, and as far as experience shows he may not even read his paper if it is returned to him. In fact, in the majority of cases, there would be no advantage in his reading the returned paper, for the corrections would not be upon it, and in many cases not even any mark to point out things that are wrong.

What is the object or purpose of this final examination?

I. Is it to find out where we as teachers have been lacking in presenting the subject? Then it is too late to benefit the pupils who take the test, and it is unjust that they should have the mark that belongs to the teacher.

II. Is it to compel the pupils to get a thorough review of the subject? This is far more effectively done by taking a definite section of the review each day for the last week or two under the supervision of the teacher and judging the pupil by his power to use the fundamentals in a calm thoughtful way.

III. Is it to give the pupil practice because he will be required to take entrance examinations for college and tests in college later? This would be worth far more to the pupil if given often as class exercises and with the teacher's corrections and advice as to improving the paper, instead of being given as a last exercise. Moreover, if the sole object of the examination is to prepare him for what college professors will require of him, then let us give it up and leave it to the professor to give it up in his turn when he realizes its uselessness. I have been told that in colleges that require entrance examinations, the percentage of failure is so great, that many pupils are allowed to enter college on condition after failing in the examination. The examination cannot be called

[1] Read before the Mathematics Section of Central Association Science and Mathematics Teachers, Des Moines Meeting, November 28, 1913.

an entrance examination in that case, and since these pupils make good, it proves that the examination is not the test of what the pupil can do.

Besides, we high school teachers who have been in close touch with these boys and girls for months, are better qualified to decide upon their ability to carry on the course in college, than a professor who simply corrects the examination paper.

IV. Is it to determine for ourselves how well the pupil can control himself during an examination, how well he can write what he knows, when pressed for time? This may be a very good object, but it demands that the teacher know what the pupil knows before he takes the test, or else how can the teacher say that certain mistakes are made because he is taking the test. More than this it seems to me unjust, that a pupil's lack in this respect should count against a particular subject or worse still against every course. I should like to give every pupil a separate valuation for cool-headedness, conscientiousness, and perseverance, just as we would in recommending him for a position.

V. Is it our object to give questions that we know they know? Do we work them up to pass the examination we have prepared? This might be done because we do not need the examination to determine the standards of our pupils but are compelled to go through the form of it and therefore make it as easy as possible for teacher and pupil. Besides that kind of an examination would give an added reason for passing them and would show our pupils off to better advantage. Another reason some teachers advance for giving easy examinations is this, "The pupils are under such a strain that it is difficult enough for them to answer the questions they know best." Can these teachers believe in the final examination? Giving this kind of a test, we hurry through the papers simply to corroborate our preconceived opinions. We also give our pupils the result of these opinions unchanged by examination results, even though we are often amazed that our best pupils go to pieces and the poorest pupils surprise us. Does this prove that we believe in the examination? The time spent on it by teacher and pupil was doubly wasted.

VI. On the other hand is it our object to give the things we think the pupils may not know, taking the last chance of arousing them to the need of getting these points before going on to the next course? If so, it is hardly fair to brand them with the mark obtained upon a set of questions on which the teacher knew they were weak, and it is rather hopeless to depend upon their getting

help from the teacher on these weak points if it is a final examination.

VII. Last, but not least, is the object of the examination to determine what the pupil knows? Is the teacher depending upon it for the pupil's standing? In my mind this is the only legitimate reason for giving an examination; but what kind of a teacher is it, that can associate with her pupils 45 minutes a day for four or eight months and not know their standing and yet can judge them and mark them upon the result of a final examination?

I think I can prove to you that the traditional examination fails both on account of the impossibility of giving fair test questions and of determining the exact value to put upon the answer.

As we sit here in this meeting we are likely to forget the exact condition of mind in which we made out our last set of final examination questions; the hopelessness of covering the subject in ten or twelve questions; the injustice of a narrow examination which would give chance results; the doubt as to whether we should give questions that are so involved that they bring out the reason, principle, and method in the pupil's mind but are very difficult to mark fairly; or whether to give those that require definite, short answers, and although very easy to grade, leave a big doubt in the mind of the examiner as to whether the pupil ever saw any connection between the question and the answer.

We all know how often the correct answer has been given from memory, chance, mechanical methods, after making two or three mistakes, by guess, or even from a neighbor's paper; and how the wrong answer has been put down by careless copying after the correct principle has been used.

We are likely to forget how we hesitated not knowing whether to give the things we had practiced upon or originals like them; whether to give simple forms of certain types or the more complex; and as the variety of types of examinations is as great as the number of teachers giving them, we can well imagine the difficulty of giving a fair set even though the object were merely to reveal to pupil or teacher his lack and did not require a percentage mark.

We are likely to forget the condition of our minds as we corrected these papers. Have we devoted days and nights to them, writing the corrections upon the papers, paying little attention to the mark, but caring only that the pupil should get these last points? In that case, how we have longed to have the pupil right there as we corrected his paper! The time given to the in-

dividual pupil in clearing up those weak points would have been no more than that consumed in correcting papers, and we would have been sure of his getting the understanding instead of feeling that he'd most likely crush his paper into a ball and throw it into the waste paper basket. I know this feeling only too well for since I am under the examination system, I use it as a last chance to bring out the pupil's weak points. After writing out upon his paper every correction, I condition him so as to withhold his mark until these points have been cleared up. Can we call the first test a final examination?

On the other hand, have we been in the habit of devoting days and nights to these papers for the sole purpose of giving them an exact grade, even to a fraction of a per cent? Then we surely must have realized the impossibility of getting an exact valuation for the individual points. If the same principle were violated in each problem did we take off each time? If the principle were sometimes violated, sometimes not, could we decide that the pupil knew it? Did we call it carelessness when he got it right, or when he got it wrong?

Did we make a difference between a mistake in principle, and one in carelessness of arithmetic? How did we mark when a pupil got one of the first steps in a proof wrong and then got all the rest right, in spite of the wrong step? When he used the conclusion in his proof? What difference did we make between the wrong answer and no answer? Between the paper that is careless from beginning to end, but finishes and the paper that is perfect as far as it goes but does not nearly finish? How did we mark the boy who put down the wrong thing, and then told us before he left the room that he realized his carelessness? How did we mark the boy who was sick while taking the examination and not at his best? The boy who was simply sleepy? Did we let either of them take it over? Did we realize that everyone else could have done better if allowed to take it over? How did we mark the boy who was not present at examination, but took it later? The boy who was present in body but whose mind was not on his work on account of trouble at home, or an injustice from teacher or pupil the hour before, or on account of the weather, the temperature of the room, or the condition of his health?

Did we account for differences in marking due to these same conditions in the teacher? His change of attitude from the first paper to the last, as to the papers corrected in the morning and

those at midnight? As to the good paper that follows many poor ones, and the equally good paper that follows other good papers? Did we consider his differing severity toward the bright pupil and the dull, the attentive and the inattentive? In my own school these differences work both ways.

With all these questions in our minds, did any of us decide after correcting the examination paper, that we had been all wrong in our estimates established by close association for months, and give the pupil the result of the test? This would be the only fair thing if we are to judge the test by its own merits and many people do this, but oh what an injustice to a pupil who knows he knows the subject and knows the teacher knows he knows it, to fail on account of a test. Some of you may think this situation impossible, but in my own school we have a minimum percentage of 61 per cent, no percentage below that can be averaged in with the monthly marks no matter how high they are, and good students may fall below 61 per cent through nervousness, fear or condition of health. In connection with this subject, we might consider the teachers' examination. Who believes that her test paper determines the kind of teacher she will make? We all know, that what a teacher knows is very little compared with the way she presents it, with her tact, with her personality. Finally has this never roused us to the realization that the examination is not the test of a pupil's ability and that even if it were, we can not put a valuation upon it because we have no uniform unit of measure for marking the paper? If there is a unit, what is it? A unit of measure must be of the same kind as the thing measured. When we give our pupils 80 per cent, what do we mean by it? It ought to mean that they have obtained 80 out of 100 of these units. To be uniform it would be necessary for every teacher to give 100 of these units in every test. Next suppose a teacher had a vague idea of this unit, would she be able to tell how many of these units each type of problem contains? For instance I have sometimes tried the plan of taking off 1 out of 10 or even $\frac{1}{2}$ of 1 per cent out of 10 per cent for a careless mistake in arithmetic or spelling, and have found that I might have to take more than 10 out of 10 which would give a negative mark without considering the principle of the problem. Furthermore if the teacher had a unit and could apply it accurately to each problem, could she define it so that all other teachers would recognize it and all be able to use a uniform system of measuring a pupil's ability? We know that this

is absolutely impossible. In other words, the ability of the pupil is each teacher's private opinion. The worth of any mark given to an examination paper depends upon the standard of the teacher. The more conscientious she is, the more she understands her subject and the more thoroughly she presents it, the more weight will her marking have. For instance a poor teacher may not be able to teach more than her weakest pupils can easily understand and she may mark them all 100 per cent, or a poor teacher may think a poor paper good because she does not recognize the mistakes; or a careless teacher may mark a poor paper high because she overlooks the mistakes. But a good teacher correcting conscientiously will recognize every mistake, and see every wrong point and a paper corrected in this way will have a lower mark than the paper corrected by the careless teacher. There is nothing to change this situation, it is human opinion and not a unit of measure by which each pupil is judged, and I would rather trust the opinion of a teacher no matter how poor she is, as to the ability the pupil has shown during months of close association with him, than the opinion of the teacher or an outsider based upon a written examination. For that matter the outsider would be more just than the prejudiced teacher, if the paper is to be marked upon its own merits.

The situation as I have outlined it may look very hopeless to you as far as suggesting any way of getting a uniform method of marking; and if there is no uniform method, then the traditional examination fails to accomplish its object no matter what that object is.

I am absolutely opposed to the traditional examination, and would like to see it die out with other useless antiquities. This is not only because I am opposed to any system that determines the standard of a pupil by answers without knowing the mind of the pupil back of the answer, but also, because I know of certain definite evils that arise from the traditional examination, such as:

First. Discouragement and fear of the test which often hinders the best work of the course.

Second. Working toward the mark of the examination rather than toward mastery of the subject and power to carry on higher things. This of course defeats the purpose and destroys the joy of the work.

Third. Cramming in the worst sense of the word which gives temporary knowledge, not power; makes machines of them in-

stead of thinkers; and sometimes fatigues the mind so that even the memory and machinery of the cramming fail them at the examination and break down follows.

Fourth. The use of translations or keys in preparing the work and in the test, and dishonesty of all kinds resorted to for the sake of the mark.

Fifth. Heartache, disgust, or indifference toward the marks, as faith in their honesty wanes.

Sixth. Injustice through honors decided by a fraction of a per cent.

Seventh. Injustice in that many teachers are required to spend so much time getting their pupils ready to pass mechanical examinations that less time is left for the logic and reasoning of real mathematics.

Eighth. Hardship to the teacher who corrects or marks low a pupil who has had high marks the year before.

Ninth. Injustice to the teacher who marks lower than the others in the same course, in that pupils will leave her for the teachers who mark higher.

Tenth. Injustice to certain elective courses as a whole if the teachers mark lower than the teachers of other elective courses; for pupils will seek the course for the sake of the mark as long as we encourage it.

When we listen to statistics in regard to teachers varying from 95 per cent to 25 per cent on the same paper when corrected by hundreds of teachers, the same statistics in regard to college professors, school principals and superintendents, when we hear of the customs of certain teachers always to give from about 80 per cent to 95 per cent; some to give many A's, others never to give any A's, we realize that most teachers in correcting papers, "can make numbers lie." We need not feel discouraged, however, if we do come to realize the worthlessness of the traditional examination. Most of us have known for years that we do not need it and this is especially true if we are leading our pupils on day by day in the logical, reasoning methods and away from the mechanical methods. We see day by day the development going on, the understanding broadening and the power to do increasing. This day-by-day work is the examination and I need the whole period of the course to give this examination, and I am gloriously happy in the results. I have certain proofs of these results that come back to me after my pupils go to college, the strongest of these being that many of their college professors

think that they are going over the subject for the second time because they have such power of attacking the new subject. But it is not in these proofs, that I rejoice. It is in the happiness that comes to my pupils day by day as they give up old, mechanical methods for an absolute understanding that gives them assurance and joy. It is their daily confession of happiness in it and love for it that more than pays for the work of teaching.

Pupils coming from the eighth grade appreciate the power of reason and understanding and tell us how they longed for reasons, how tired they were of being told that they were to do certain things because mathematicians had agreed upon it. How tired they were of using a model problem and doing all others like it without knowing what they were doing. How we have suffered and labored to undo the work of teachers who have taught the pupils to change signs, to take things from one side of an equation and put them on the other side. I must not take your time to enumerate the thousand and one thoughtless, barbarous things that are done even by seniors under the name of those two processes, and yet the teachers who taught them claimed that they did not want it to be mechanical until after it was understood. The point is that after they are once taught to be mechanical the work of undoing it is enormous, but we must undo it; and no matter how difficult the task we get our recompense when the light dawns on them. When it does, they often tell us that they never knew before that they could use mind or reasoning in mathematics. Third and fourth year pupils often acknowledge that they have never used reasoning in any mathematics up to that time. Is it any wonder that they love mathematics when through it they learn the power of their own minds? We have heard much at this meeting about the speed tests and the mechanical processes of mathematics. Speed is not wanted anywhere in life at the sacrifice of reason and conscientiousness. The wrong placing of a decimal point in a prescription, the turning of the wrong switch on a railroad track, the Titanic disaster, the harm to our foreign policies through unreliable press information, are all due to speed without reason or conscientiousness. The result without the principle is seen in the greed for wealth, the corporations, the sweating system, child labor, and corrupt politics; while the same principle of mechanical mathematics results in life in the machine man who can do nothing but what is outlined for him, who is a Democrat because his father was, a Methodist because his ancestors were. Really, I would

rather my pupils had no mathematics than to have the mechanical kind. That does not mean that I do not believe in doing certain mathematical processes so quickly that they seem mechanical but that I believe this rapid work should never be done until after the understanding of the reason back of the process has been so thorough, that it is in truth the very cause for what seems mechanical. And as I struggle for weeks to make them understand the reasons for processes that nine-tenths of the pupils do mechanically, I know that unless you too are struggling with them in this way, you little know how mechanical they are. In order to accomplish this object, I have been teaching almost entirely without a text-book for the last five years or more. With suggestive questions from me, in what is called the inductive or heuristic method, my pupils do plane and solid geometry and trigonometry as original work. The very question asked suggests the method of attack. In beginning algebra, we do not have a text for the first two or three months. This time is spent in teaching them to translate English into algebra and algebra into English. Professor Stanton of Ames College would enjoy this emphasis upon the English side. This time is needed to teach them that they are really meant to tell the truth about the conditions, to mean what they say and to do what they promise to do. Surely I am not alone in experiencing this condition of having them answer anything imaginable to any question we may ask. Pupils coming in from the eighth grade usually add up all the unknown numbers and put the sum equal to the given known number, no matter whether the problem calls the known number, sum, difference, product or quotient. I have adopted a method that compels beginners to read the problem, ponder over what it says, and take an interest in understanding the meaning. This method brings out clearer thinking. Many of you may be doing the same thing, but I'll explain it for the sake of those who have not tried it. Even before we let a letter stand for an unknown quantity we hunt for the sentence that tells about the known number. Generally this comes at the end of the problem. For instance after describing five numbers the problem may read, "If one-half the second number be subtracted from three times the fifth number, the remainder will be 62." We always label the number in names, but with mathematical signs. Thus, 62 = 3 times 5th No. $-\frac{1}{2}$ 2nd No. The most difficult part of the work is to get the label from the words of the books. Suppose the problem ends with "The fourth number exceeds one-third the fifth number by

17." Then our first statement would be 17 = 4th No.—$\frac{1}{3}$ 5th No. The work of the whole problem is practically done when they get this label. Then by means of letters representing the unknown quantities we find what x expression is 3 times 5th No.—$\frac{1}{2}$ 2nd No.; this is no trouble at all to the weakest pupil. Then the x expression equals 62 because each of them equals the same thing (3 times 5th No.—$\frac{1}{2}$ 2nd No.) and the weakest pupil sees that reason and enjoys it. Or a still simpler method we use oftener is to find what 3 times 5th No. is in x and substitute a thing for its equal, and then substitute for $\frac{1}{2}$ 2nd No. in x. It takes time to make them do this, but the clearness and accuracy of their work afterwards pay for it. Mr. Charles H. Smith, spoke at the dinner last night of spending weeks if necessary to get in harmony with the pupils. I spend months simply in getting them into the spirit of mathematics, in helping them to know that it is the truth we want, that there is a principle to be followed and that it is not mathematics to do things mechanically or say things because we have heard others say them. If there is any subject in school that can teach them that they must mean what they say and do what they promise, it is geometry without a text-book. I enjoyed Professor Caldwell's reference to truth and justice in his address yesterday, because I know that in teaching mathematics, I am teaching life. Can you think of anything more practical or of more use in the vocations than honesty, conscientiousness, and truth? I tell my pupils that all there is of mathematics or of life is to face the situation conscientiously and then tell the truth about it, and do what you promise to do. Mr. Short may not call this vocational; Professor Cajori may not call it practical, and he says the practical problem is needed to make the pupil love mathematics and understand the principles. I know that they love it when they understand it and a very practical and helpful side of algebra is to turn to arithmetic every time they are in doubt and see what they would do there. One of the greatest dangers is to let them get the impression that algebra is something new and different from arithmetic. I do not care, however, which they have first—the practical problem or the reasoning, but I do stand for such perfect understanding that it must be practical.

Now you must be wondering what all this has to do with the traditional examination and the marking system. I claim that we do not need the traditional examination if the pupil's very thoughts are being examined every hour. Not only is it easier

to judge our pupils when the reason precedes the doing, when all the questions are—"What would you use?"—"What does that depend upon?"—"Why would you do it that way?"—"What is your reason?"—"What would you do?"—but even if we were compelled to give a mark, there is a system that I find quite satisfactory. In the first place I have introduced a volunteering system which I have not time to go into fully here, for it has taken me about five years to work it down to a science but every pupil recites on every point which gives every question the force of an examination. Each pupil counts one for each correct answer or proposition or problem. We keep the marks for the different grades of questions separate, and then the pupil is arranged in order or rank in each type. For instance, one may be at the head of the class in whole problems, one in originality, one in review questions, one in perseverance or industry. Then the pupils are placed in the order of their final ability, all things being considered—from my own point of view of course—and then I decide upon the standing of the highest and lowest and arrange the others between them in their order. Since in our school we rank by letters, I distribute the letters in order from the first to last. If I had my way no percentage would be given and no letters to stand for a percentage—the letter simply gives a little more freedom anyway. I would divide them into three groups: excellent, mediocre, and poor. It is that great middle group that gives all the trouble anyway. I would be willing to send that middle group on to higher work. The next teacher might find some of them excellent, some poor but it would be more just to the majority.

I talk this frankly with my pupils and there is a great satisfaction in it. They acknowledge its justice and are more satisfied with the mark when I acknowledge that it is simply comparative and that I cannot tell exactly what they are worth. They go around to pupils of other teachers and other schools and investigate the power of these pupils and compare their marks and so judge the worth of the marks of different teachers. In conclusion, let me say that I do not object to the tests of our committee if they are taken for what they are worth. They are interesting as far as showing what the participants did in them. They are very much like a debate. They do not settle the question; they do not determine the ability of those taking part, they do not reflect honor or dishonor upon the trainer. The uncertainty in human nature is too great to allow us to say that the one who does best today will be as good tomorrow, and all that these different tests could

tell us, even if we had a unit of measure, would be who did best today in this test.

I went to Champaign last week to see what information I could get on this subject from the Courtis Tests. I got none and Professor Lunn of Chicago University convinced me more than ever that there is absolutely no method of grading the ability of a pupil. I have come here today to hear Professor Cajori. I am prejudiced I know, but I cannot see what method he can give us. I claim however that we do not need it as far as our work is concerned; a final examination cannot make it better or worse. And since I believe that the teacher must be trusted, for it is her judgment, with or without final examination out, there is only one thing for us to do—to work day and night conscientiously to give our pupils the power to be thinking men and women, not only in mathematics but in life.

We must make the character of our work so high that our valuation of our pupils as to whether they are excellent, mediocre, or poor can be trusted and corroborated by those who carry them on. We must love our work more and more as we understand it better and not be of that class to which Mr. Perry Smith referred as not loving the work themselves, therefore not able to make their pupils love it; but loving it, with all our minds our pupils cannot fail to love it and as Kipling says:

> "Each in the joy of the working,
> And each in his separate star,
> Shall paint the thing as he *sees* it,
> For the God of things as they are."

FLOWERING PLANT FORMS.

The true flowering plants divide naturally into the two groups of Monocotyledons and Dicotyledons, the separation depending upon whether they have one or two seed leaves. The dicots comprise by far the larger group, a conservative estimate placing their number at nearly 110,000 species while the monocots number less than 25,000. In the dicots there are approximately 46,000 species with sympetalous flowers, that is, with parts united, and 62,000 with polypetalous and apetalous flowers. In this latter group, 50,000, or nearly five-sixths, have superior ovaries. In the sympetalous flowers, 22,000, or about half, have superior ovaries. Approximately 12,000 plants in the monocots have superior ovaries. A curious thing connected with this subject is the fact that there are practically no monocots with sympetalous flowers. The few instances that occur, such as *Convallaria, Asparagus* and *Aletris* serve as the exceptions which prove the rule.—*American Botanist.*

FAILURES IN PHYSICS AT THE COLLEGE ENTRANCE EXAMINATION BOARD—THE CAUSES AND THE REMEDIES.

By Sidney Aylmer-Small.

The reasons why boys are failing in large numbers at the Board examinations in physics are in order of importance:

(1) The difficulty of the subject.
(2) Neglect of written tests.
(3) Poor teaching.
(4) Character of the standard set by the Board.

Physics is a very difficult subject, because it is given as a one-year subject.

All one year subjects are difficult because the subject must be introduced, inertia overcome, acceleration produced, and a review done in 36 to 40 weeks. Physics is an especially difficult one year subject because it often has no similar subject ahead of it. Neither is it a part of the system of subjects as trigonometry is a part of mathematics, or French a part of a language group.

Moreover, it is more than one subject.

As the Bible is a library of books bound into one cover for the convenience of Christian people, so is the physics text a library of pamphlets bound into a book for the convenience of science students. The contents of these pamphlets, and the order of binding them may be such as to show some continuity, but the teacher must start the class afresh, overcome the surface tension of the mind and develop an acceleration seven times a year. The mechanics of solids, mechanics of liquids, mechanics of gases, light, sound, heat, and electricity constitute seven groups of ideas which must be presented together, and although some of the ideas are not new, yet they are viewed from a new angle in each group. Hence, a physics class practically starts afresh seven times in the year.

The great trouble is retention of previous work while busy with the difficulties of something quite new and different. Suppose the colleges demanded a language course in our schools, consisting of an elementary knowledge of seven Teutonic or say seven Romance languages. Suppose the language teacher must prepare the classes for a fairly stiff examination in this sevenfold subject in one year.

Can you hear the protests of the teachers and of the principals. Yet we do the equivalent of this every year, as we teach physics.

Again, physics is a quantitative subject:

Exact results are demanded; and to obtain these the student must be accurate at arithmetical computation, must have a working knowledge of algebra and geometry (mark that this is quite different from book knowledge), must be able to solve problems (this is a difficult thing to teach some boys), must have a common sense which will act as a check against absurd results (such as finding a red hot iron bar to be at a temperature of 200 deg. Cent.).

The remedy for the difficulty of physics lies along the lines of: First—precede physics with a good one year course in General Science with the emphasis on the physics part of it. Second is the selection of the facts, theories, and explanations to be included in the physics course. This involves how much of the old historical matter we shall omit, and how much of the newer theories we shall bring in. For success at the Board examinations you must select the topics which are in their syllabus. If you add to them you are educating but are not preparing for the Board's examinations.

Much of the inherent difficulty of our subject is overcome by a copious use of cross-references, so that the students may grasp the interrelations of the different parts of physics. For instance: Start with liquids and teach all you care to about them. With the hydraulic press explain the levers used in connection with its pump. When you come to mechanics of solids and are teaching the lever refer back to the hydraulic press. Proceeding in this way we are continually pre-viewing and reviewing. So that in the latter part of our instruction we are in the main developing friendship with old acquaintances and recalling to mind things that we have heard about before.

To sum up: The remedy for the difficulty of the subject lies in:

A preparatory course in general science.

The student shall have no mathematical conditions.

Teach from the C. E. E. B. syllabus.

In teaching these topics eliminate descriptions of old junk, and the modern theories not belonging to elementary physics.

Pre-view, review, and cross-refer at every possible point.

After the difficulty of the group of subjects called physics causes many to fail through lack of knowledge, another part of the candidates fail by reason of their inability to pass written examinations. I have read for the Board the answer papers of over one thousand candidates, and have seen how poorly arranged and how incoherent many of the answers have been.

The art of taking written examinations is not taught. Perhaps the teachers feel that giving, correcting, and discussing numerous written tests takes too much of their time and of the time of the class. Perhaps teachers do not realize the importance of such instruction, do not realize that to get into college through the C. E. E. B. a written examination must be taken. To pass a written examination a candidate should not be persistently coached in oral work. I know that parents, relatives, and friends judge a boy's education by talks with him, hence we should see that our pupils are able to talk intelligently about their knowledge. In conversation with students in and out of the class room clear and concise language should be insisted upon. One reason why I do not like oral recitations is that you can not mark the answers fairly as all do not get the same questions. Another reason is that many of the answers will be either wrong, or slovenly, or inaccurate. In any of these cases I do not want the other pupils to hear the answer. Formal, graded oral recitations do more harm than good, for in them students hear much that is incorrect, carelessly worded, or badly put together. I want my boys to hear little else than truth expressed in terse, clean-cut statements.

The only excuse for even informal and unmarked oral work is that in it a student hears his mistake and realizes it at once and keenly, too, while in written work it is necessary to rub his nose against the mistake. In informal, unmarked oral work should a boy start to answer wrongly I cut him off and say "What you mean is this ——, is it not?" Of course a tricky boy may once in a while say "Yes." But I care little, for I am not marking.

In physics I never grade oral work. Since the thing that will get a boy into college is the ability to pass written examinations we must not only give much written work, but we must correct it, and see that the student pays attention to them. Moreover, these corrections must show mistakes in method and form, in coherence and emphasis, as well as in physics. Reduce oral work to the least possible amount, increase the written work up to the limit of the teacher's strength and health. As long as written work does not interfere with explanations too much of it can hardly be done. In order to find time for written work the time of lecture table demonstration work can be reduced until no class room experiments are performed except those necessary to make certain laws clear. The teacher is not

responsible for the difficulty of physics but he is for neglect of written work. By written work is meant "written under the eye of the teacher in absolute silence like an examination." This written work should be graded severely, as too often a false confidence is given to a student by rating his work more leniently than any college will rate it.

In regard to poor teaching: One great fault is starting the year easily. One must promptly in the first week grasp the class by the seat of its attention and boost it over the wall of its mental resistance or through the hedge of its mental apathy. Another fault is over emphasis on some part of the subject with neglect to some other portion. Some teachers devote too much time to laboratory work, neglecting the discussing of laboratory work in the class room. Too much time can be devoted to class room experimentation by the teacher. Luckily, the great expense of the equipment, and the lack of time to prepare them acts as a brake on this. In some rich schools where teachers are not overworked, too much demonstrating is done. A teacher may let a class talk too much, he may even compel them to talk too much by questioning them. A clear and interesting explanation by the teacher sticks in the mind, while the poor and patchy explanation drawn out by questioning will make no impression on the students. It can not, for it is too lumpy to be assimilated.

Giving problems to be done and teaching how to solve problems are different things. The second may be neglected. From reading answer papers I feel that it is neglected. Nothing short of a systematic method of instruction as to how to do problems in the best way, showing how to approach and how to close up a problem will do. Simply getting the correct result is not enough in school. The boy should attack the problem in a reasoning manner, all the arithmetical work should be indicated before results are written. The mental processes by which results are obtained should be clearly indicated. It must occupy sufficient paper and be so displayed on this paper so that the eye may follow the order of the student's work. Results should be labelled with the name of the unit. Answers manifestly absurd when tested by common sense should be considered disgraceful. The remedy for poor teaching is for each one of us to be sure of our own methods. We must be self critical. When a student fails to pass a written test ask ourselves whether it is all his fault or can we trace his low marks to poor methods of instruction. Good teachers in general are born, but good teachers of any particular subject are made, and usually self-made at that.

A cause of failure at the Board examinations is that the Readers set a standard which is moderately high and is consistent. This standard is based on the C. E. E. B. syllabus, hence freak methods or very broad and comprehensive methods will probably not prepare a boy for the Board's test. The standard being definite means that indefinite methods will not do. The standard being high means that a teacher must be up to concert pitch, and have good material to work with. Many teachers set too low a standard and are not consistent. By this I mean that their written tests are too easy and their gradings of them are too much influenced by the general run of the marks, and by the character of the boy whose paper they are reading. A high standard should be set. It may well be 10% higher than the Readers at the Board set, for the strain of the occasion, the presence of strange proctors in the room both tend to reduce the passing ability of the students.

There is a tendency among teachers to fit the test to the occasion. The class has had a "slump" so the test is made easier or is marked less sharply. Since a teacher knows what his class ought to be able to do, let him set his tests and the scale of ratings a long time ahead; and let him give and mark according to this scale. It would be well if all written work and tests were made out during the summer vacations and filed away ready for use, never being looked at again until the actual time of the test. It is good for the teacher to be somewhat in ignorance of the exact questions in the test. Tests are frequently set with too little care. Drafting them in vacation avoids this. Tests should be made out with the utmost care, tried on the class, revised in minor details, mimeographed and used several times in the future. A good test will do for four times spread over six years.

Where the questions are written on the blackboard several annoyances occur: All the students cannot see every question with equal ease. Students must read the question, then copy the data in full, then check up the accuracy of the copy. While solving they must frequently reread the question from the board. This involves a deal of looking up and down which breaks into their concentration. In justice to the student he should have his individual copy of the test. Students should be given tests in which there is a choice in order that they may have practice in choosing wisely.

The character of the Board's examination involves:

A two hour examination.

A choice of questions.

An element of surprise.

Students should be trained for two hour sustained concentration by having such tests at school. No instructor can forecast the Board paper so shrewdly but that his students will get a jolt of surprise at some one question. Boys must be trained for these jolts. If in each of the tests at school there is placed some unexpected question which would make the students' eyes blink, then the boys would not be bothered by similar surprises at the Board, in fact the boy will be expecting them. When a boy says to a teacher "Your tests are harder than the Board's examinations," you may be sure that the student will feel no "pit of the stomach" when he comes to the Board's test.

TO SUMMARIZE: Teach from the Board's syllabus. Pre-view, review and cross-refer as you teach. Have much written work like the Board's under exam conditions. Train them to do problems. Have an invariable standard as high or higher than that of the Board.

A MEDICAL OPINION ON UP-TO-DATE DANCES.

The latter-day dances have been discussed and criticized from almost every standpoint. To complete the list, *The Journal of the American Medical Association* has recently raised its dignified and professional editorial voice in gentle warning. "It seems somewhat late," it says, "to enter a mild protest against the fervor with which the newest 'so-called' dances have been taken up by a public already saturated with various nerve- and mind-destroying amusements and caprices. It seems unnecessary to call attention to the fact that the tango, the various waltzes, the maxixe, etc., are being arduously cultivated by callow youth and caloused old age. The problems created by these dances differ according to the age of the participants; for the young the question of morality is paramount; for the old the possibility of too great a strain on a dilated heart or an arteriosclerotic vessel is apparent. The physician will do well to caution the stiff-jointed, aged patient, who derives too great a pleasure from those—to him—potentially harmful amusements."

THE PROBLEM OF THE LOADED TABLE.

By Ernest R. von Nardroff,
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In a well known recent text-book a problem similar to the following occurs.

"A table, 3 feet by 4 feet, has a leg at each of its four corners, A, B, C, D. The table supports a load of 120 lbs. at a point 1 ft. from the long side, AB, and 1 ft. from the short side, AD. What is the pressure, due to this load, at the foot of each leg? Ans. A, 60 lbs.; B, 20 lbs.; C, 10 lbs.; D, 30 lbs."

This problem has created considerable discussion among teachers.

The answer given by the authors suggests that they attempted to solve the problem by the method of moments alone. Apparently it was argued, and that quite correctly, that the side, AB, supports $\frac{2}{3}$ of the load, or 80 lbs. And apparently it was assumed, but this quite gratuitously, that of this 80 lbs. the leg, A, supports $\frac{3}{4}$, or 60 lbs. Similarly for the other legs. Unfortunately, both the method and the answer are wrong. Let us look into the problem more carefully. Using in succession the line joining each pair of legs, DC, AD, BA, CB, as an axis of moments, we get at once the following equations.

(1) $A + B = 80$ lbs.
(2) $B + C = 30$ lbs.
(3) $C + D = 40$ lbs.
(4) $D + A = 90$ lbs.

Any attempt to solve these equations will result in failure. In fact, the equations, while simultaneous, are not independent; thus, (4) may be deduced from (1), (2), and (3). As they stand, these equations may be satisfied by an infinite number of sets of values. Thus, if to A we assign any value chosen at random, say 70 lbs., definite values for the other legs follow immediately; that is, B= 10 lbs., C=20 lbs and D=20 lbs. This seems rather puzzling, for when an ordinary table rests upon an ordinary floor there is surely only one set of values for the pressures at the feet of the legs. How then shall we calculate this single set of values? We must take into account some condition that will furnish an equation independent of (1), (2) and (3), for we need four independent equations in order to solve for four unknown quantities.

Everybody knows that the pressures at the feet of table legs depend upon slight inequalities in the length of the legs and upon

slight inequalities in the level of the floor. But, perhaps, it is supposed that with a perfectly symmetrical table and a perfectly level floor the pressures at the feet are dependent merely upon the amount and the position of the load. If so, the elastic yielding of the floor and table has been overlooked. And here lies the solution of our problem; it is here that we can find the needed additional independent equation.

It is clear, now that we come to look at it, that for each law of elastic yielding that we may assume, there is a single set of pressure values at the feet. Let us assume a very simple law. Let us assume that the table itself is perfectly rigid and unyielding but that the floor yields locally in exact proportion to the local load, the yielding qualities being the same in one part of the floor as in another. If the table is perfectly rigid, then when it is loaded and its feet have sunk into the yielding floor, these feet must continue to be in a perfect plane. Hence, the slope of the line joining the feet, A and B, must be the same as the slope of the line joining the feet, D and C; that is, the yielding at A exceeds the yielding at B by precisely the amount that the yielding at D exceeds the yielding at C. Further, from the particular law of yielding assumed, we conclude that the pressure at A exceeds the pressure at B by precisely the amount that the pressure at D exceeds the pressure at C. And this gives us at once the needed additional independent equation, namely,

$$A - B = D - C. \tag{5}$$

Solving the group of equations, (1), (2), (3), and (5), we get

$$A = 55 \text{ lbs.}$$
$$B = 25 \text{ lbs.}$$
$$C = 5 \text{ lbs.}$$
$$D = 35 \text{ lbs.}$$

The law of yielding on the basis of which these pressures were calculated may easily be realized experimentally; ordinary spring balances yield in exact proportion to the load. Here is an experiment I tried recently.

To represent the table I supported a thick piece of board, 9 inches by 12 inches, by means of four cheap spring balances, *all of the same pattern*, hooked over wire nails driven into the corner edges of the board, these edges being first chamfered. The balances themselves were rigidly supported by heavy retort stands. I adjusted the height of the upper supports so that the balances recorded approximately equal weights. Then from a small screw

eye attached to the under side of the board, 3 inches from AB and 3 inches from AD, I hung a weight of 3000 grams, and noted the new readings. The observed and the calculated pressures agree as closely as could be expected with uncorrected balances.

Foot of table leg.	A	B	C	D
Reading of balances, board alone	222 g.	125 g.	202 g.	152 g.
Reading of balances, with load of 3000 grams	1579 g.	733 g.	328 g.	1036 g.
Pressures *observed* at corners due to load	1375 g.	608 g.	126 g.	884 g.
Pressures *calculated* at corners by above method	1375 g.	625 g.	125 g.	875 g.

If some other law of yielding were assumed we would arrive at an entirely different set of pressure values. Thus, we might assume the yielding to be proportional to the square root or to the cube root of the pressure. In these cases, however, the calculations become very involved and lengthy, and they would drive us to graphic methods for a solution.

What pressures would prevail if a perfectly rigid loaded table rested on a perfectly rigid and level floor I cannot say, and I do not think anybody could say. For, infinite rigidity is the limiting case of an infinite number of different laws of yielding. With one *law* of yielding there would be only one set of pressure values, no matter what the coefficient of yielding, even though this coefficient approached zero, and so if a floor should gradually become more and more rigid until it became infinitely rigid we should expect the pressures at that stage to be the same as those associated with the particular law of yielding possessed by the floor. With a different kind of floor stiffened to infinite rigidity we should expect a different result for the pressure values. And as there are an infinite number of kinds of floor possible, each with its own peculiar law of yielding, we should expect at infinite rigidity an infinite number of sets of pressure values possible, and with nothing to decide more in favor of one set than another. So, there we are.

THE GENERAL VALUE OF GRAPHS.

By E. B. Hodges,
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Correlation of the various subjects in the curriculum has been discussed and various theories have been advanced only to be cast aside in actual practice. The theory discussed in the present paper seems to be a very practicable one, because first while not needing to be labeled there is actual correlation and second in connection with the correlation there is much of actual enlightenment on the subject under discussion. It is a psychological appeal to the eye.

Graphic work is a practicable theory and method of correlation. In history a graph similar to the following enables easy chronological comparison, the great men or events are seen in relation to other events and their time and relative importance designated by the line. The cost of war equipment, the relative strength of nations, in fact nearly all history can be reduced to a graph.

	1650	1700	1750
A			Albany Council
B	Bacon's rebellion		Bunker Hill
C	College of Wm. and Mary		Columbia U. founded
D			Declaration of Ind.
E			
F	Free Schools in Mass.	Freedom of Press	First Cont. Congress
G		Georgia founded	
H			Henry's resolutions

1800	1850	1900
Annex Texas	Appomattox	
	Confederacy	Child Labor Laws
	Dred Scott Decision	
	Emancipation	Emergency Currency
Florida purchase	Fort Sumter	
	Gadsden Purchase	
Hartford Convention		Hague Conference

(Names in alphabetical order from top to bottom for ease of reference.)

In literature a similar graph may be made showing the periods of greatest activity; and by the use of heavy or colored lines the relative importance of poetry and prose and the drama may be indicated for each period.

In economics there are many practical applications such as the comparison of value of articles at different times, as of silver, the commercial activity of the various nations at different periods, the increase of trusts and decrease relatively of competition, and relation of imports to exports.

In civics the length of term of the different officers may be compared, the relative importance of the various courts shown, and the interlocking powers of national, state, and local governments indicated by the interlocking circles. In geography, altitudes, lengths of rivers, amount of coast lines, number of miles and relative importance of railroads, location and development of industries, amounts of rainfall, and many other items may be graphed.

In nature study the graph is very important. Before the child has started to school he has learned to outline the architecture of buildings with blocks, or, outdoors in the autumn, with leaves. In the kindergarten this tendency is still further developed. Later in the course, botany, biology, and zoölogy claim attention along this line. The study of bone structure is made more plain by the use of diagrams.

The study of the development of grammar, the origin of words, the relative number of nouns, adjectives, adverbs, and other parts of speech in one's own vocabulary may be shown. But perhaps the widest range of the graph in the school work is in mathematics. The child early learns to graph cubes and other forms and to draw straight and curved lines. Then he learns to add one line or block to another. In subtraction, multiplication, division, the solution of simultaneous and quadratic equations the direct appeal to the sense of sight by means of a picture helps to clear up the subject.

But the greatest value of the graph is the correlation with actual life. It is said that education is preparation for complete living. Is the graph used in practical life? That is where the greatest correlation occurs, school life in all its phases being correlated with actual business and professional life. Is the child to be a scientific farmer? He needs to graph the line of profits for the various departments; he needs to look at a graph of his farm to see where he can save space or make things handier. Is the child to be a business man? A graph will show the general range of prices for several years giving him a basis for estimations as to the time of year to buy, the quantity of goods to be purchased and the general market conditions. Is he to be an archi-

tect? The designs are practically all graphs. Or an engineer? The grading, placing of underground pipes, the plans for bridges and culverts, electrical and chemical problems, the mechanism of different kinds of machinery are all graphed and must be understood. Artists, cartoonists, advertisers, publishers, carpenters, brick-masons, and practically all people can and do make use of the graph.

As graphs are of value in correlating school work, in the development and better understanding of all subjects of the curriculum, as they apply the knowledge gained in school to the problems of actual life, as it is important that they be understood in nearly all vocations, all students should have a working knowledge of the principles of graphical construction.

STAND UP STRAIGHT AND GET THE FULL HORSEPOWER OUT OF YOUR HUMAN MACHINE.

The way the human body is used is of the utmost importance if the person is to have the best of health of which the person is capable. With a person it is much the same as with the automobile. One represents a 50-horsepower engine, another a 40, another a 30, still another 20, and if the body is used rightly this full amount of energy can be developed without harm. If the body is used wrongly, as is true with the machine, it may be ruined in developing half the amount of the designed horsepower. When rightly used, the parts are all in balance; there is no undue strain to any part, the chest is carried high, so that the breathing is easy, and there is the full amount of "wind power." The abdominal organs are properly supported and work with the least difficulty, the digestion and nutrition are good. If the body is drooped or buckles in the middle, the whole body suffers, and many times disease conditions start in this way. In such drooped position the chest is flattened, so that the lungs cannot work rightly and become weak, the abdomen is telescoped and the stomach, bowels and other organs are crowded together and work badly, so that indigestion and constipation result. Health, or the best possible efficiency, the full horsepower of the person, cannot result under such conditions any more than an engine can develop its rated horsepower if the cylinders are full of carbon, or that the fuel in the furnace can be consumed properly if the drafts are not properly open or the ashes are not removed. The position most favorable for health and in which the load or burden of life can be carried most easily is with the body, both when sitting and when standing, as it would be if a person were trying to sit or stand as tall as possible. This gives the high chest, the flat abdomen, the erect head, square shoulders, straight knees, and the springs of the whole body are set in the best way. This is the position recognized by the athletic trainers, by the singing-teachers and by all those who are expected to train individuals for great effort. The same position is best for everyone, whether the effort be great or small, or whether the work be with the head or muscle.

APPLE DAY, AS OBSERVED BY A HIGH SCHOOL BOTANY CLASS.

By Denman Cruttenden, 1915,
High School, Quincy, Ill.

[In view of the present interest in methods which bring the science work into closer contact with life and experience, it appears worth while to call attention to the manner of attack represented by the following paper. In this case a variety of problems were approached from the side of the pupil's interest in practical apple growing. The field and class work were of course outlined in advance by the teacher. The paper is the work of a pupil in the high school of Quincy, Ill. The teacher of the class in botany is O. D. Frank.]

On the Saturday before Apple Day our high school botany class visited Mr. Williamson's apple orchards, about three miles from town, for the purpose of studying the systematic growing of apples.

As we entered the orchard down a lane grown up with orchard grass, we saw several men on Indian ladders (straight beams with cross-pieces, and braced at the bottom to keep them from turning) with sack and baskets, picking in trees laden with juicy, red Winesaps.

The trees were about thirty feet apart, and pruned free from injured branches; on one side of the lane was a tract of young trees, whose bark, we noticed, was much smoother than the bark on old trees.

We noticed the buds, branches, bark, leaves, and fruit spurs of the trees, and were also interested in the birds' nests in them. In this way we went on with our eyes "peeled," discovering new secrets of Nature at every step, until we came to a small clearing, where we saw several men sorting apples, apples in sacks and loose in piles, and a wagon, which was being loaded with barrels of apples.

One of the men, who proved to be the "boss," came to meet us, and after glancing at our card of introduction, expressed himself ready to answer any questions.

We had worked up an appetite on our tramp, and seeing one of the boys look wistfully at the piles of gorgeous, mellow beauties, our guide took the hint and invited us to help ourselves. which we did with a will.

He told us that they had about twenty pickers, two teamsters,

four sorters, and four packers working. He also named some of the standard varieties, as Winesap, Jonathan, Grimes Golden, and Ben Davis, and gave the number of trees of each.

Our instructor having inquired about the quality of the soil, the guide told us it was a clay subsoil, containing quantities of limestone. In fact, we had seen evidences of limestone on our way out.

When questioned about spraying, he stated that much of his success as an apple grower was due to careful spraying against insects, the Codlin Moth and San Jose Scale in particular.

Some of the boys having watched the packers at work, remarked about the skill and rapidity with which they worked, as well as the care taken, whereupon our host explained to us the methods used in sorting and packing.

The sorters stood around a large table with boards nailed on the sides to keep the apples from rolling off. The apples were brought in by the pickers and heaped upon the table, from which the sorters took them, sorting them into Firsts, Seconds and Culls.

The apples for local sale were packed in sacks, but those for shipment were packed in barrels. First a layer of evenly sized apples was put in the barrel; it was then filled nearly to the top, and another layer put in, the facers at the top and bottom giving the barrel a neat appearance.

Our host told us they had all they could do to ship the prime apples without bothering about the specked and mellow apples, which were taken to the cider mill or fed to the hogs.

Our interest had fought off our appetites until now, but as it was high noon we sat down by the well to eat our lunch, when out came our host's good wife with a bowl of apple-sauce, several apple pies, and a pitcher of cream. We seemed to have met with too much of a good thing, for by two o'clock we all abhorred the sight of an apple, and so for comfort's sake we took the train home, a sadder and a wiser class.

The next Monday we brought apples to class, shined and labeled them and set them out on tables to be examined and have their names learned. We kept them on exhibition for several days.

Each student took two apples and studied in regard to the kind, color, shape, size, peculiarities; shape, size, length, color, texture, of the stem; the stem end, and blossom end, date of maturity; color, thickness, texture, odor, bloom, peculiarities, of the skin; color, texture, and flavor of the flesh; texture, number of cells and use of core; number, color, and arrangement of seeds.

In our botany note-books we made drawings of an apple entire, a cross-section, longitudinal-section; a seed entire, cross-section, and longitudinal-section.

The next day, which was Apple Day, our parents, superintendent and members of the faculty were invited to inspect our display. A special table of apples was prepared for them and all ate and talked about apples.

As part of our program the pupils read themes which they had prepared on the following subjects: "Origin and Development of the Apple"; "Extent of Apple Growing"; "Kinds of Apples"; "Kinds of Soil and Location Best Suited to Apple Growing"; "Budding and Grafting"; "Pruning"; "Diseases of the Apple Tree and Its Fruits"; "Insects that Visit the Apple Tree"; "Orchards as Nesting Places for Birds"; "Gathering, Packing, Shipping" (this described the Indian ladders, buckets, sacks, barrels, boxes, and cider press); "Qualities and Uses of Apple Tree Wood" (wood for tool handles, bark for dyeing, blossoms for perfume); "The Age of Apple Trees When They Begin to Bear"; "Average Length of Life"; "Apple Producing Sections in the United States," the writer of this theme having dough maps showing the sections in colors; "Apple Statistics"; "The Apple in Song and Story," in which were mentioned "Planting of the Apple Tree," "The Three Golden Apples," and "Apple Seed Johnnie"; "Apple Games of Today and Yesterday"; "Other Fruits that Bear the Name of Apple," as pineapple, May-apple, thorn, cactus, hedge, rose, cedar, balsam, and "Possum Apples"; "Apple Expressions" —"In Apple Pie Order," "Apple of My Eye," "Adam's Apple"; "The Story of An Apple Tree," from planting of the seed to the throwing away of the core, telling of the parts, uses of each part, color change, number, arrangement, planting and development after suspended animation of the seed, the parts of the tree and the uses of each part in the growth of the tree, the beautiful buds, parts of the blossoms, uses of the parts, color (a white flag waving to the bees) odor, pollination and fertilization of the blossom, and the fruit spurs, the leaf buds, parts of the leaf, uses of the parts, uses of leaves, shape, size and color of the leaf, and why the leaves develop later than the blossoms, the fruit, at first small, green, sour, hard, uninviting, seems to say, "Don't eat me," later—still green, sour, hard, ugly, full of groans, still later—ripe, richly colored, sweet, mellow, juicy, pretty, fragrant, temptingly inviting, seems to say, "Come pick me; take me and eat me—but—throw away the core that my seeds may be planted so that I may

have children as useful as myself"; the last theme was upon the subject, "The Uses of Apples," and told of apples raw—"in the cellar in red and yeller heaps," cider, vinegar, and Apple Jack (a misuse of a useful fruit), and of apples cooked—apple sauce and apple pies, ways of cooking, canning, drying, and preserving apples.

After the program we spent a little while "visiting," and left school that day feeling that Apple Day was really a very useful day, at least it had been useful to us, as it taught us the importance of the greatest of all fruits.

STAMPING OUT HOOKWORM IN THE SOUTH.

In eleven southern states the campaign for the eradication of hookworm is being conducted along the most aggressive lines. For the quarter ending September 30, 1913, 133,125 microscopic examinations were made for hookworm. This parasite of the human body is a bloodsucker and does much injury to the intestinal lining, where in adult life he makes his abode for six to ten years unless dislodged by thymol treatment. During the three months 33,671 persons have been treated for the disease. Of this number 4,447 persons were reported by physicians and 29,224 persons were treated in free dispensaries conducted by the health departments of the state and county in Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, So. Carolina, Tennessee, Texas and Virginia. In these eleven states there are 1.042 counties, of which 417 have made local appropriations to aid in defraying the expenses for the free examination and treatment. The work is very popular and it is usual for a fifth to a third of the entire population of a county to be examined to ascertain if infection exists. In Lee county, Virginia, 9,013 persons were recently examined and in several counties over 8,000 persons have been examined.

In every county where this work is conducted infection and sanitary surveys are made on a uniform basis, so that the health authorities may know just what problems confront them. By making comparisons with future surveys the progress being made can be ascertained. Approximately $15,000 has been spent during the past three months by the local agencies for the extension of this work. The Rockefeller Sanitary Commission, with headquarters at Washington, is lending liberal support to the work.

In addition to getting the infected people treated; the sanitary and infection surveys made; conducting extensive county campaigns through the use of lectures, the printed page, and the free dispnsary demonstration work; enlisting the press, etc., much progress is being made in getting sanitary closets installed as a means to stopping soil pollution and ultimately controlling the channel through which hookworm disease and typhoid fever spread.

ON THE "QUANTUM" THEORY OF LIGHT.

By L. P. Sieg, Ph. D.,

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A glance at the development of physics will reveal the fact that every period has been characterized by a certain center of interest and attention. In some cases one center of interest has maintained itself for many years; in others it has occupied the focus of attention for but a brief time. Again, a one-time popular class of phenomena will reappear for discussion with new vigor, after an absence of years. As a necessary result of the antiquity of physics, most of the phenomena of nature have at one time or another occupied this prominent position. Many have come for but a brief stay and have then left apparently for good; others have come and gone, only to come again and yet again. As a further result of these many centuries of close scrutiny of nature's laws, we have accumulated under the domain of physics a body of knowledge so vast as well nigh to overcome one with its immensity. By sheer force of intellect, and experimental perseverance man has pushed back the boundaries, that lie on every side, further and yet further into the realms of the unknown, until today we have gained such confidence in human powers that we feel convinced that what was once thought to be unknown will surely advance to the state of being known, and what was once thought to be unknowable will just as surely advance to the merely unknown. The best minds in the field of physics today are working at that portion of the boundary of knowledge that is concerned with the ultimate constitution of that which occupies the universe of nature—of those portions which we call matter, and of those other portions which we call non-matter, or ether.

This study of matter and ether is one of those subjects in physics which have persistently reappeared upon the center of the stage throughout the centuries. My purpose is by no means to discuss in detail or even in general the manifold aspects of this subject, rather it is, to discuss, and by necessity but briefly, the aspects of this subject wherein matter and ether are inseparably connected. I refer to radiation. Radiation, I may add parenthetically, is not the subject of my paper, but a discussion of radiation is positively necessary for any adequate understanding of

[1] Paper read before the Physics Section of the Ceneral Association of Science and Mathematics Teachers, at the Des Moines meeting, Nov. 28, 1913.

the so-called Quantum theories of light. And may I offer one further introductory idea at this point, before I go to the matter in hand. I want to offer a plea for broad-mindedness and toleration to those who are unfamiliar with this theory, for I fear that you may be led to think that some of your time-honored ideas and ideals will be shattered or at least profoundly shaken. All of us are prone to accept certain ideas in physics as mere matters of ritual. We learn the ritual once, and learn it perhaps only after severe mental effort. After that we resent very decidedly being compelled to change our position. All the history of physics, and for that matter of every other field of human knowledge, is replete with examples of this. I want to assure you concerning the subject under discussion today that these new ideas of radiation are just exactly as well founded and as logical as the old. I want to urge any doubters to question their own belief carefully and rigorously to see if their positions are any more tenable than are the new ones.

Now as to radiation. Why are we interested in this subject? The answer is that radiation of so-called electro-magnetic waves is the best connecting link we have between the two things that fill space; matter, and "not matter" or, let us say for the present, ether. If we can learn anything more about these two entities, then we are amply justified in our studies. Let me state then, at the outset, what information we have of these two entities, as connected by radiation. We know that every body in the universe is sending energy to every other body. We call the process radiation. You stand close to a stove and you are aware that something comes to your sense organs, which you call heat. You stand close to a cake of ice and you again detect its presence without the necessity of material contact. Your sophisticated mind tells you that heat is leaving your body more rapidly than it is being received. So, not to be diffuse in this regard, I state that we recognize that matter is radiating energy from itself and is simultaneously receiving energy from outside. If we examine this radiant energy by suitable apparatus we find that it seems to have all the properties of a wave, and further with other apparatus we can resolve this wave into component parts, running from waves of infinitesimally short lengths to those of infinite lengths. Not only that, but further, we find that the energy of this radiation is not equally distributed among these waves but is so distributed that there is one maximum for a certain wave length, and that the energy falls off for wave lengths

both shorter and longer than this one. It may be of interest to you to know that in an ordinary room the objects are all radiating, and that the wave length of this radiation that contains the maximum energy is about 1/3000th of an inch, while on the other hand the sun's radiation finds its maximum at a wave length of about 1/50000th of an inch, or in the yellow-green portion of the spectrum. The above illustration has anticipated my next point, which is merely that this radiation depends upon temperature and that the higher the temperature, the shorter the wave length at which the maximum occurs. This fact, coupled with the fact that the total energy sent out from a body is proportional to the fourth power of its temperature above absolute zero, constitutes a very essential part of our information of radiation from the standpoint of the hot body.

Now from the standpoint of the ether we have a very satisfactory body of knowledge. Maxwell long ago showed how an ether might be devised, containing certain electric and magnetic properties, which would carry for us this complicated wave constituting radiation. When this radiation is once well started on its way in the ether, Maxwell's theory handles its progress beautifully. It accounts for a definite speed of propagation; it accounts for interference and diffraction. It accounts, albeit somewhat clumsily, for reflection at various kinds of surfaces, polarization and absorption. However, it does not connect the matter just discussed—temperature and radiant energy—with propagation through the ether. So after all, one can very serious doubt, in view of what we know of radiation, that we know the connecting link between the heating of a body and the subsequent appearance in space of the radiant energy. There is missing a very important connecting link. This connection is missing, even in view of the modern electrical theories. To sum up this portion of the discussion we say that in the radiation from material bodies there is associated with every wave length for a given temperature a certain amount of energy, which is a function solely of the wave length and the temperature. The exact type of this function we do not know. It has remained for the Quantum Theory to advance a type of function more nearly agreeing with the facts than any previously known. And, judged solely on this basis, it is a theory well worthy of our serious study.

Before we consider this recent theory, it is important to consider certain functions connecting energy with wave length and temperature, that have resulted from the study of classic

thermodynamics and electrodynamics. Remember that any such function must satisfy a condition of equilibrium on the one hand between the kinetic heat energy of the molecules of matter and the electric contents of these molecules, and on the other hand between these electrical contents and what we are pleased to call free radiation in space. It will help greatly throughout this discussion if we imagine a certain space to be enclosed, with walls absolutely impermeable to radiation, and in this space to imagine present together matter in the form, say of an ideal gas, at low pressure and at any given temperature, and its radiation. The walls are to be maintained at the same temperature as the enclosed gas. Further keep in mind that there is supposed to be equilibrium attained in this space, wherein a certain portion of the energy is in the matter and a certain other portion is in the ether, and so the balance stays, no matter what constant interchange in this energy there may be.

We shall first look at Rayleigh's function which shall be discussed as briefly as possible. The energy possessed by the matter is, if sufficient matter is present, supposed to be divided up into as many portions as there are degrees of freedom, and each of these degrees of freedom possesses its even share of the energy. If there are N molecules present, there are $3N$ degrees of freedom, and so too $3N$ separate portions of the energy. Arguing on this basis, and using the laws of Maxwell, and laws from the kinetic theory of gases, Rayleigh arrived at a certain algebraic expression connecting the total energy and temperature. On the basis of the above laws, no one has successfully contradicted Rayleigh's formula. The only successful contradiction has come from experimental facts. The serious objections are these. His formula does not lead to the characteristic maximum of which I spoke at the beginning; the expression for the total energy is only true for long waves at any given temperature, and more seriously still, his hypothesis of equi-partition of energy among all the degrees of freedom of motion will necessarily lead to an equilibrium state wherein all the energy in our enclosure is contained in the ether, while the matter therein is at practically absolute zero. This is because, from the evidence of continuous spectra, the ether possesses an infinite number of degrees of freedom.

It was in an attempt to so modify the idea of equi-partition that it would not lead to inconsistencies, that led Jeans to announce a modification of Rayleigh's theory. In brief Jeans admits

the infinite number of degrees of freedom of the ether, but says that the ones characterized by extremely rapid vibrations, and those characterized by extremely slow vibrations are so vastly less important that the total energy is, so to speak, temporarily divided among the $3N$ degrees of freedom possessed by the gas molecules, plus the number of degrees in the ether between certain limits. The number of these degrees is by no means infinite. There is then the possibility of a quasi equilibrium between matter and ether, although in the course of a great time, the ether must take practically all the energy.

Yet another function has been developed, this one by Wien, from the standpoint of electrodynamics and the laws of thermodynamics. This function has been successful in that it has accounted for a certain definite maximum of the energy at a given temperature and wave length. It is unsatisfactory because it fits the experimental facts only at the short wave length end of the spectrum. It may be added that the exact function connecting these quantities has not been discovered. Wien simply has shown that as soon as the form of the function is known for one temperature, it becomes known for all temperatures. The laws of thermodynamics and of electrodynamics are not competent to give the exact form of the function. We must first form a clear picture of what is going on in the atom.

It remained for Planck to arrive at an expression for this function which seems to fit the facts of experiment with great exactness. It would be in a short time, a physical impossibility for me to indicate the steps by which Planck arrived at his formula. His assumptions, however, are: first, that our matter in the enclosure is composed of a great number of vibrating resonators, each of which is the equivalent, if you please, of a wireless telegraph generator, *i. e.*, a Hertz *oscillator*. Each of these has its own period. There is equilibrium between the vibrators and the ether, and the relation between these is obtained by electrodynamics. There is also equilibrium between the molecules and these resonators. It is in this last relation that Planck has made one of his unique assumptions. He has abandoned equi-partition of energy, and has arrived at the distribution of energy among the molecules and resonators through a consideration of probability or chance. It is strange that the same laws that govern legitimate games of chance should stand us in good stead for the solution of problems of radiation! I am sorry that I cannot take up with you step by step, equation by equation, this remarkable develop-

ment. Here, as in other portions of this paper, I must content myself with a few of the more interesting of the deductions.

Those who are familiar with physics will know that there are certain processes in nature that are irreversible. Among them are the natural expansion of a gas, conduction of heat from a hotter to a colder body, and heat lost through friction. There is a law in thermodynamics, the second law, that says of these three —they are irreversible processes, it is the way nature acts, and whenever she so acts, she has laid up against her records an increase in something we call entropy. Never has an absolute proof been given for the second law of thermodynamics. We have simply never been able to find an exception. Planck, from the work of Boltzmann, has found a reason for our lack of a proof of this law, for it cannot be proved. It rests on pure chance. In Planck's way of looking at it the three facts spoken of above, the matter of expansion, conduction, and friction, should be stated in this fashion. It is very safe to say that these three things will always happen in nature, but it is not at all a certainty. In other words, a gas might sometime of itself contract, heat might sometime go, of itself, from a colder to a hotter body, and the heat usually wasted in friction might sometime turn itself back to useful work. Just a matter of chance, although the chance is vastly in favor of the usual phenomena. Take the first case of the gas. The molecules are moving in all conceivable directions. Why might they not at some time or other take it into their heads, so to speak, to move all in one direction? If so the gas could easily be seen to contract. So then Planck has used Boltzmann's expression for the entropy of our material body in terms of probability. But even this has not been sufficient. He has, lastly, in order to be able to count up the probability, been compelled to assume that the energy which a body expels, *must not flow out uniformly, but must be sent out explosively in integral numbers of a fundamental unit of energy*. He is able to account for uniform absorption of energy, but not for its uniform emission.

I have now in brief outlined the general aspects of the subject, and have shown, perhaps not nearly so completely and conclusively as might be desired, the points in which classic electrodynamics and thermodynamics have failed to account for even the most obvious facts of radiation. And lastly, I have outlined in brief the essential features of Planck's Quantum Hypothesis. We must now look into this latter theory and review those fields of radiation in which the theory has met not only success, but

also failure, for you must know that the complete solution of the problem is by no means at hand. Again let me restate the situation, and enumerate the essential postulates of the theory, for it is on these postulates that we want to focus our attention throughout the remainder of this paper.

The general problem is to find a consistent connection between the energy of radiation in space and the heat energy in matter, this energy to be determined as a function of the wave length and the absolute temperature. Classic electrodynamics and thermodynamics, based as they are on Hamilton's Principle, which necessarily implies the validity of the concept of equi-partition among all the degrees of freedom, and based also upon laws of continuity, have been found to fail in the solution. Starting on quite new grounds and abandoning much of the classic principles of electrodynamics and thermodynamics, Planck has developed a wholly new function, and one, too, that has been eminently successful. The whole foundation of his theory is contained in his statement in the preface to his treatise on Radiation. "Entropy is a countable thing, varying from zero to infinity in its magnitude, and not, as in classic thermodynamics, running from positive to negative infinity." Seen more in detail his postulates are three in number: first, equilibrium on the basis of electrodynamics between radiation and the oscillators in the atoms of matter; second, the entropy of a body is a function of the probability of its present state; and, lastly, the emission of energy from a body in finite units. I have already illustrated the bearing of probability on entropy. It will perhaps be well to look further into the reason for assuming definite energy units, and some of the consequences of this assumption.

The first, and most important reason for explosive radiation as distinguished from continuous emission of energy, comes from the necessity of being able to handle a finite number of energy units in determining the probability of any certain state of the body. Poincaré has said that since radiation depends upon vibrating matter, and since vibrating matter is discontinuous, then it is not at all illogical to assume that radiation is made up of discontinuities. Sir Oliver Lodge in his presidential address before the British Association warned his hearers that we may some day even come to the belief that time itself is doled out in discontinuous bundles, and that our existence may, in view of some future theory, prove to be no more continuous than the pictures thrown from the cinematograph. But to return to the discussion of these finite bundles of energy.

On both sound theoretical and experimental grounds, Planck came to the conclusion that these energy units, while finite and definite, were not all of the same size. In fact, the expression for the magnitude of this element of energy is $\epsilon = hn$, when n is the frequency of vibration of the oscillator, and h is a universal constant in radiation, called by Planck the universal *Wirkumgsquantum,* or operating quantity. We must later say more of this important constant, h. We learn from this expression that when an oscillator has a high frequency, there is associated with it a large unit of energy, while a low frequency oscillator can emit a much smaller unit of energy. This gives us without further details, an idea why so little energy is found in the violet end of the spectrum. Simply because in order to radiate here, it requires the absorption of much larger energy units. There are a host of verifications for this assumption in other realms of physics. For example, Nernst and his associates working on the subject of heat capacities of bodies at various temperatures, but particularly at extremely low temperatures, find remarkable agreement between experiment and theory. The reason for the low heat capacities at low temperatures and their increase with temperature, the reason for the law of Dulong and Petit concerning atomic heats, the derivation of many of the classic laws of gas theory—all have been indicators of the success of the Quantum idea, in this domain.

(Continued in the April Issue.)

GASOLINE REFINING BY A NEW METHOD.

Under a new process which the Standard Oil Company of Indiana is installing, at Whiting, it is believed that it will be possible to convert 75 per cent of crude petroleum into gasoline. The process opens the way for breaking up the hydrocarbons of petroleum into the combinations needed and condensing them under compression.

PLAY AND GAMES IN ARITHMETIC.

By Myrtie Collier,
California State Normal School, Los Angeles.

Technique in the fundamental processes and the application of number facts to the arithmetical problems of daily life is the aim of a large part of the instruction in the arithmetic of the elementary schools. This aim necessitates a great amount of drill, but with all the time spent in drill from the first grade through the eighth we are unable to reach the high standard of efficiency desired. The aim, however, is of little significance to the pupil unless the subject be made interesting. One of the great pedagogical questions is how to eliminate the waste of both time and energy in the acquisition of arithmetical knowledge. Could it be that play or games in arithmetic would help to eliminate this waste by creating an interest on the part of the pupils?

Much has been done during the last few years with the subject of play in education by those particularly interested in child study. Regardless of the theory of the source of play, whether we agree with Spencer that it is the overflow of energy, or with G. Stanley Hall that it is an evoluntionary process, or with Gross that it is the outcropping of inherited instincts, we all recognize its strength and usefulness.

We may use the play element in education either by introducing the playful into the work by making the pleasure in the activity the motive power, or by performing the work through real play where the aim is superseded by enjoyment of the activity itself. Of the latter Gross says, "It can hardly be doubted that this is the highest and noblest form of work."

All so-called play is not necessarily play. Since there is joy in work, and work in play, can the psychologist draw a hard and fast line between work and play? "President Eliot has enumerated the sources of joy in work as:

1. The pleasure of exertion.
2. Achievement, particularly competitive achievement.
3. Co-operation, involving harmony and rhythm.
4. Exercise of judgment, intelligence, and skill.
5. Encountering risks, danger, making adventure.

These five sources may also be the chief sources of pleasure in play."[1] To make a success of the play element in education the teacher must have the playful spirit herself. She must be

[1] Charles W. Hunt, *Teachers College Record.*

able to direct the play of children without destroying their freedom and genuineness, to encourage what is good and useful, and to discourage that which is not only flippant but also injurious and improper.

Do not understand this discussion to be a plea for "soft pedagogy." That is not the aim. Nor is it an argument that the principles of arithmetic be developed through play. The principles should be inductively derived by the pupils of the class in such a manner that all mystery in arithmetical operations be removed. This calls for a logical arrangement of subject-matter, and for a psychological presentation of each step. Such arrangement and presentation gives a pleasure to the work, but that is a thing aside from play and drill although it is necessary for the success of the latter.

There are certain well established facts about the play and games of children upon which we may base our games in arithmetic. Young children like to play alone, later they play in groups, and at a still later development games of competition and of conquest are the more attractive. To quote again C. W. Hunt, "It will be noted that play is not a thing by itself, but that it concerns the expression of many kinds of instincts. Some of these are curiosity, personal power, bodily and mental activity, imitation, competition, construction, collecting, co-operation, rhythm, risk, and chance. A game should possess other appealing qualities, such as freedom, pleasure-giving, spontaneity, surprise, variety, and difficulty. These elements cannot be combined mechanically." Children of one environment fashion their play along one line, and in another environment along another line although the principle of the play be the same. For this reason one should not use a set of games with a class of children unless the games are in some way connected with the environments of the class. Let each teacher, therefore, make her own games after a thorough study of her pupils.

Last spring it was my pleasure to put through a little test in the use of games in arithmetic by the aid of a student of the Normal School working in the city schools. We selected the fourth grade. The pupils were very much interested in baseball at that season of the year and we outlined a baseball game to be played with numbers in which the children "played that they played baseball." A short time before the city had been interested in an automobile road race. A road race was outlined in numbers in which the racing was done in numbers instead of

machines. Lastly the children fitted up a department store and played store, care being taken by the teacher to see that the cost of many of the articles was marked in fractions for a drill in the use of fractions. In all these games the children were allowed the freedom that is theirs by right, namely, to move about the room and enjoy their work, but at the same time were led to see and respect the rights of others. Throughout the test a record was kept of the amount and grade of work done in formal drill, and in the drill through games. It was a positive test, showing that the amount and accuracy of the work in the play surpassed that in formal drill.

As a word of caution may we say that great care should be taken that the pupils are not overworked in this form of drill.

A NOTICE FOR LIVE SCIENCE TEACHERS.

The writer is pursuing an inquiry into a problem of science teaching which involves the two general questions: (1) The general attitude of girls toward science studies, and (2) the results of segregation of sex in this field of study. The information was not at hand that would have enabled direct communication with those teachers who were by observation and experience most capable of passing judgment. Therefore it was thought that a notice in this publication would not only reach those best qualified to give opinions but likewise would reach those of the craft who have the problems of science teaching sufficiently at heart to co-operate. Incidently, it may be said that the writer believes this to be a very pertinent problem at this time.

Below are the questions, opinions on which from as many science teachers as care to reply, would be gratefully received by W. W. D. Sones, Woolslair High School, Pittsburgh, Pa.

Name of School ————.

I. In your opinion is the general attitude of girls favorable or unfavorable toward science studies?

(a) Which of the high school sciences appeals to them most?

(b) Which least?

(c) If you have had experience with general science classes, what topics have you found the girls most interested in?

(d) With the exception of the subject of physics do you think the interests of boys and girls vary much?

II. Has segregation of sex increased the efficiency of science work?

(a) In what subjects?

(b) Which was varied most when girls were taught separately, content, or method of approach?

(c) What is the relative ability of boys and girls when each are interested?

COLLOIDAL COMMON SALT.

By Nicholas Knight,
Cornell College.

In connection with the interesting papers on colloids in the November and December numbers of this Journal, by Dr. Harry N. Holmes, and in the January number, by Dr. Theodore Cohen, we thought it might be worth while to call attention to the preparation of colloidal common salt. Colloidal chemistry is rapidly growing in importance. Numerous books on the subject have recently appeared, and a journal is published in the interest of this branch of chemical science. The time has doubtless come when it should receive attention in every high school course in chemistry, and some colloidal experiments should be made in the laboratory work.

The experiment herein described was first made by Professor Carl Paal, formerly of the University of Erlangen, but now a professor in the laboratory of applied chemistry of the University of Leipsic. His paper was published in the *Berichte,* Band II, 1906, page 1436.

Two grams of sodium in small pieces are added to 100 grams of benzene, and 30 grams are distilled off into a dry flask, rejecting the first portion of the distillate. Then 5 grams of malonic ethel ester are dissolved in this 30 grams of sodium-dried benzene, and 0.7 gram sodium in the form of fine wire is added. It is warmed on the Water-bath with a perpendicular condenser attached to the flask, to complete the reaction. To the solution are added 4 grams of chlor acetic ester, and the contents of the flask are warmed. The orange-colored opalescent liquid is cooled and then treated with five or six times its volume of low-boiling petroleum ether. After the light colored, fine precipitate has settled, the liquid is poured off, and the residue is washed twice by decantation with petroleum ether. The precipitate is filtered under a watch glass to exclude moisture from the air, washed with petroleum ether, and dried in a vacuum desiccator. The amount of the colloidal salt should be 1.846 grams. Besides the salt, ethelyn tricarballylic acid ethel ester is formed in accordance with the following:

$$ClCH_2 \cdot COOC_2H_5 + CH \begin{matrix} \diagup \\ \diagdown \end{matrix} C \begin{matrix} \diagup ONa \\ \diagdown OC_2H_5 \\ \diagdown COOC_2H_5 \end{matrix} = C_{11}H_{18}O_6NaCl =$$

$$C_2H_5O_2C.CH_2.CH(CO_2C_2H_5)_2 + NaCl$$

This experiment, we believe, can be carried out in the ordinary high school laboratory. The sodium wire can be purchased of the usual dealers or the apparatus for making the wire can be imported duty-free for nine dollars.

By a similar process we made colloidal potassium chloride, and were proceeding to make other sodium and potassium halides when we found that Professor Paal had already attended to these preparations.

Further references: *Berichte*, Band III, 1906, page 2859, 2863; 1909, Band I, page 277, 291.

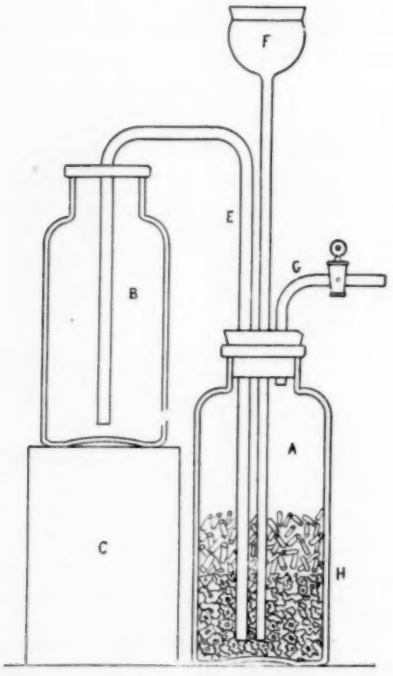
ROYAL COMMISSION ON VENEREAL DISEASES.

The King of England has approved of the appointment of a royal commission to inquire into the subject of venereal diseases in the United Kingdom, their effects on the health of the community, and the means by which these effects can be alleviated or prevented, it being understood that no return to the policy or provisions of the contagious diseases acts is to be regarded as falling within the scope of the inquiry. These acts provided for the compulsory examination and detention of prostitutes. The public feeling aroused against them grew so much that their reintroduction in any form is out of the question. According to the London correspondent of *The Journal of the American Medical Association*, the appointment of this commission may be traced to the resolution passed at the International Medical Congress. It is composed of prominent public men and women, clergymen and a number of medical specialists (Sir Malcolm Morris, Sir John Collie, Dr. Mott, Mr. Ernest Lane and Mrs. Scharlieb). For a long time attempts have been made to induce the government to appoint this commission. In 1899 memorials were presented to Lord Salisbury (then prime minister) by the royal colleges of surgeons of England and Ireland and the British Medical Association, but the breaking out of the Boer War caused the subject to be shelved. In the same year the International Congress on Venereal Diseases was held at Brussels and resolutions were passed urging the various governments to appoint commissions of inquiry. The congress declared definitely against anything in the nature of the contagious diseases acts. Next a discussion on the subject took place at the Royal Society of Medicine in 1912. In June of this year Sir Malcolm Morris published an article in the *Lancet*, which received editorial support, asking for the appointment of a royal commission and drawing attention to the grave dangers of venereal disease being contracted innocently. Later a letter was published in the *Morning Post* asking for the appointment of a royal commission, signed by the presidents of the royal colleges of physicians and surgeons, the professors of medicine in the universities, and the presidents of the medical societies. This letter was endorsed by the representative meeting of the British Medical Association. A remarkable feature of the situation is the open manner in which the lay press has discussed the problem of venereal disease. During the meetings of the congress columns of the leading journals, the *Times* and *Morning Post* in particular, were devoted to discussions on syphilis. A few years ago these journals would scarcely dare to print the word and would use some periphrasis such as "a certain contagious disease."

AUTOMATIC GAS GENERATOR.

By Robert W. Curtis,
College of the City of New York.

The need in emergency of an apparatus to supply hydrogen sulphide for class use resulted in the improvisation in a few minutes, from materials at hand, of the type shown in the cut—and it worked.



The bottle A is 16 oz. salt mouth, B 12 oz. and the block C $4\frac{3}{4}$ in. high. The tubes E and F must fit the stopper so as to be gas tight and yet allow sliding the stopper. Size No. 4 glass tubing may be used for E in order to allow easy passage of fluid through it. The outlet G is provided with a glass stop-cock; a pinch-cock could be used on the rubber connection. A short piece of capillary tubing sealed to or connected with G prevents waste and favors even working.

In charging the apparatus the rubber stopper is pushed up on the tubes E and F which are held in place while broken acid resisting material, almost "any old thing" (fire-brick was used), is dropped in A to the level of H, and evenly distributed by shaking. Above that goes a layer of the material for generating the gas.

The rubber stopper is then pushed down into place, the stop-cock outlet opened and dilute acid or other reagent, sufficient to rise above H, is added through F. When the stop-cock is closed, the siphon E becomes operative and the apparatus is thereafter automatic.

This form of generator has several advantages. The acid in passing back and forth is thoroughly mixed with the spent liquid. Fresh acid is readily added at any time through F or in B. The whole apparatus can be rinsed out without disturbing any adjustments through F and E. There is no possibility of the leakage of the liquid reagent.

A difficulty with many forms of apparatus is their "running down" by continuous slight action when not in use, as over night, due to small leakage of gas. This is effectually prevented by lifting the bottle A thus removing E from dipping in the liquid in B, and placing A where any dripping from E falls into a sink or beaker. To start up it is only necessary to replace A and introduce through F, enough of the liquid to fill E.

If the siphon is "lost" at any time it is but the matter of a moment to refill E similarly. If the admission thus, of a little air into the gas, is objectionable, F may be replaced by a separatory funnel.

The arrangement is so simple, portable, and easily set up that several can be put into commission as the needs of a class require.

A variation is the substitution of a three-necked Woulfe bottle for A. The central neck could be closed by the stopper carrying the outlet G, which, when removed, would render easier the replenishing of the solid reagent.

As indicated the combination shown gave satisfaction under the conditions. Dimensions could be varied to meet other requirements, as increasing the height of C to obtain greater pressure, or the size of A to give greater reservoir capacity, or the diameter of B to increase the supply of liquid reagent without much increase of pressure.

ERRATUM.

The position of the figures on pages 116 and 118, February number, should be so that the Z is at the top.

A MACHINE FOR TRISECTING ANGLES.

By Alfred H. Thiessen,
Salt Lake City, Utah.

A recent newspaper account of a machine constructed by a student in Philadelphia for trisecting an angle called to my mind a machine that I made long ago to bisect angles. Anyone might have conceived of such a machine, which readily follows from the standard geometrical method of bisecting angles. In Figure 1 let the links OA, AC, CB, and BO be of equal length, with joints at the points marked by small circles, and the pin of joint C sliding in a slot in OC. Then OC always bisects the angle MON.

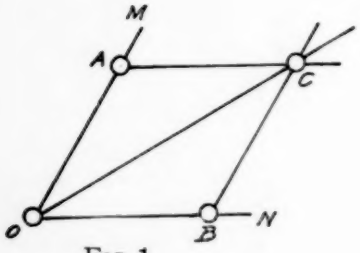


Fig. 1.

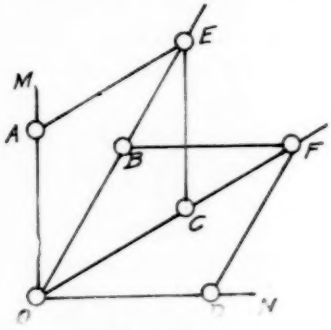


Fig. 2.

This question then arose: Can this machine be modified so as to trisect angles? In Figure 2 let the links OA, AE, EC, CO, OB, BF, FD and DO be equal and jointed at the points marked by small circles, and the pins of the joints at E and F slide in slots in OE and OF, respectively. If the angle MON be increased or decreased, the three angles MOE, EOF, and FON are always equal, hence angle MON is trisected.

While in theory the machine will trisect any angle from 0° to 270° directly, in practice it can be used to trisect angles up to 180°; angles from 180° to 360° can be bisected and each half trisected, two divisions so made forming one-third the original angle. A model of this machine can easily be constructed with cardboard strips.

A HALO AND A RAINBOW.

By Howard E. Simpson,
University of North Dakota.

The January number of School Science and Mathematics contained a brief account of the occurrence of "A Curious Phenomenon" observed at the University of Arkansas at 10:00 a. m. on November 1, 1913.

It was stated that a portion of a small rainbow was seen between the sun and the zenith. The center of the bow was near the zenith and the convex side was turned toward the sun; the outer side was red, the inner violet. The editor asked for an explanation of the phenomena.

Similar phenomena have been observed at the University of North Dakota though never as a solitary bow. This bow was a portion of a solar halo. It was the arc of a ring centering at the zenith and tangent to the outer of two halos which have the sun for a center. It is known as the upper tangential arc and is closely related to the sun dogs, or mock suns, which are frequently seen on both sides of the sun on a crisp bright winter morning. The phenomenon described was unusual in that it was so clearly visible without the more common parts of the system of halos. It was also unusual in its brilliant coloring and in the time and place of its occurrence. Halos reach their highest perfection and are most frequently observed in northern latitudes in the depth of winter.

The cause of the halo lies in the thin veil of cirrus clouds composed of minute ice needles. The refraction and reflection of the sunlight from these little prisms of ice cause the halo in all of its forms. Definite colors of the spectrum are produced by refraction when the needle-like prisms are definitely oriented as in falling.

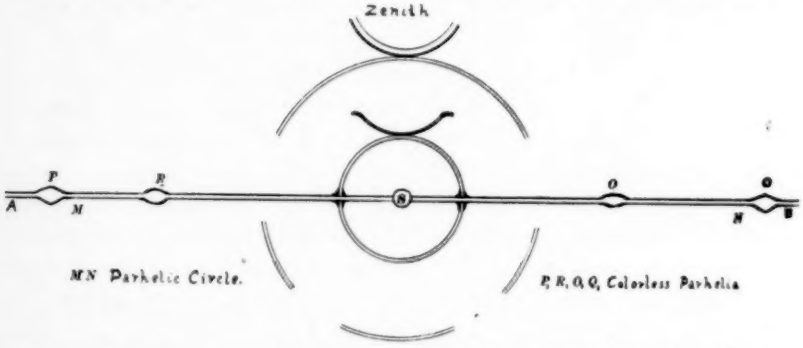
That the phenomenon observed in Arkansas was not a rainbow may be shown by reference to the occurrence of a true rainbow under conditions somewhat similar to those described. The passengers of a train going from Des Moines to Knoxville, Iowa, about noon one day during the Christmas holidays a few years ago were surprised to see a beautiful rainbow of good form and color low down in the northern sky. A slight rain had fallen and the clouds were very broken. A rainbow in the north at noon is a curious phenomenon but one easily acounted for under the conditions mentioned.

EXPLANATION OF "A CURIOUS PHENOMENON."

By J. A. Sinclair,
New Hampton, N. H.

In reply to your question under the article headed "A Curious Phenomenon" on page 82 of the January number of School Science and Mathematics, I submit herewith a rough drawing, data, and an explanation of a most remarkable phenomenon which was witnessed by nearly all our village people and students.

Careful notes which I made at the time give the following data: On February 6, 1910, at 1:00 p. m. we noticed two circles around the sun, both showing the colors of the spectrum. The inner circle of about 22 degrees radius was very bright. The outer circle was not as bright and was broken into four parts as shown in the drawing. Tangent to the inner circle at a point directly



above the sun was an arc somewhat narrower than the circle, with the extremities bent outward. This also showed the colors of the rainbow. Nearly overhead and tangent to the outer circle was a very wide arc, bright as the brightest rainbow with colors in the same order as the rainbow. The center of the circle of which this arc was a part was very near the zenith. Passing through the sun and completely around the sky at the same angle of elevation as the sun was a colorless circle with four colorless nodes. The nodes in the northwest and northeast were the larger and sharper on the sides. Those farther south were more rounded. All these circles and arcs were plainly visible until about 2:00 p. m. The circles then gradually faded away, but the "Sun Dogs" and the arc near the zenith did not disappear until about 4:00 p. m. There was no wind. The weather was very cold. The air even near the earth was full of sparkling ice crystals. The sky everywhere was filled with them.

The explanation of the cause of these halos or curves is found in almost every text-book of advanced Physics. The ordinary circle of 22 degrees radius is explained as follows: A small crystal of ice generally takes the form of a right hexagonal prism. Two alternate prismatic faces would form a 60 degree prism. From the measured index of refraction of ice such a prism would have a minimum deviation of about 22 degrees. Now, if the air is filled with these minute crystals, all of those which are at nearly this angular distance from the sun and have approximately the proper orientation will refract light toward the eye. Those nearer can not do so since 22 degrees is the minimum angle. On the other hand, crystals at a greater angular distance from the sun can divert light toward the eye if they have a very delicate adjustment of orientation, but the proportion of those so favorably situated rapidly decreases with increasing angular distance from the sun. Thus only a narrow band of light is seen. The cause of the color of the circle is evident from the different refractive powers of the prism for different wave lengths.

The outer circle is produced in a similar manner by the dihedral angle of 90 degrees formed by the sides and bases of the prisms but is of 46 degrees radius.

Now since there was no wind we may assume that the ice crystals in falling would have a general likeness in direction. Thus there would be a prevailing constancy in direction of their axes. Those having their axes vertical would cause the tangent arc to the outer circle, and also the parhelic circle. To explain the arc tangent to the smaller circle we must assume that some crystals fall with their axes horizontal.

The halo observed by Prof. Ripley was probably the same as the arc tangent to the outer circle in the phenomenon observed here, but owing to weather conditions or the lack of the ice crystals in the other parts of the sky the other circles or halos failed to appear. I believe that such a complete series of halos as we saw here is extremely rare. We would be glad to hear from others who have witnessed such a phenomenon.

PLANT STUDIES SHOULD PRECEDE ANIMAL STUDIES IN A HIGH SCHOOL COURSE IN GENERAL SCIENCE.[1]

By John F. Garber,
Yeatman High School.

One of the most significant features of the modern teaching of science in the high school is the general unrest and dissatisfaction with the results obtained as measured by the interest of the pupils and by the effects as measured by the influence on their preparation for life work. This is a most hopeful condition for out of it may be expected to grow more rational methods, a more suitable selection of material and a more logical sequence of topics. This dissatisfaction does not mean that teachers are less efficient than formerly but it does mean that we appreciate our shortcomings more keenly than before.

Not only do we not get the results we desire but we are at a loss to know the exact cause of our failure. Science instruction is becoming less popular year by year according to carefully compiled statistics while the discoveries and important applications of science to everyday affairs is rapidly increasing. Evidently something is amiss that science fails to appeal to high school students as it should, especially students in the first two years, and hence an almost universal desire for reform in that part of high school science.

As an explanation of one of our difficulties, I venture to give as a cause the constantly increasing specialization that has come about in recent years. The body of scientific knowledge has grown to such proportions in our higher institutions of learning that a small host of professors is required to administer the various divisions and subdivisions of the science instruction.

This is just as it should be in the university but the spirit of specialization has worked its way down to the high school through teachers trained in these highly specialized schools without the necessary training in methods of reducing this material to the level of comprehension of the average high school student. Science instruction in the home and the elementary school has not been able to keep pace with the advances in the university and so there has developed a great chasm which must be bridged by the high school instructor in the first two years as best he can.

From the condition just mentioned there has developed much

[1] Read before the Biology Section, Central Association Science and Mathematics Teachers, Des Moines, Iowa, November 28, 1913.

discussion as to the place which each subject should have in the high school course with a very decided preference by every one for the third or fourth year. My contention is that there is no inherent quality in any division of science which requires its subject matter to be so abstruse that it shall absolutely demand the mature development of a third or fourth year high school student to master it. Much of what is taught to high school seniors or university freshmen may be assimilated by new juniors if it is properly presented.

This specialization has forced the minds of high school freshmen into specialized molds while they were still in an undifferentiated state and before they had had an opportunity to take a brief survey of the general field. Hence the dissatisfaction with science study.

One of the important questions at present is, what is the best order in which to present the various branches of science? If we wish to take a selfish view, we may consult our own desires and decide that the pupil should take the subjects which we wish him to take and at such a time in his course as we think he would be best qualified to comprehend our subject as we wish to teach it to him. Or we can make the needs of the pupil our governing factor and so shape our course as to secure the greatest good to the greatest number regardless of the violence it may do to our preconceived notions.

That the pupil's needs require a more gradual transition from his state of general information, more or less accurate in character, to that of formal science study is evident to all who have had extensive, thoughtful experience with high school freshmen. In advocating today the precedence of plant studies to animal studies I may say that my theories are based on eight years of almost exclusive teaching of high school science in the first year so that I am reasonably sure that the things proposed can be taught with pleasure and profit to beginning ninth grade pupils if need be.

Precedence as used in this paper should be understood to mean precedence of emphasis on plant topics, but not to the exclusion of related topics. Let it be understood that I believe for certain reasons it is better to introduce the learner to living things through the medium of plants, chiefly, rather than through animals.

First let us inquire what are the purposes of these earlier studies in biological science? To my mind, they are for the purpose of bringing the pupil into more intimate touch with his immediate

environment, to answer the questions that rise in his mind about living things that he finds there, to help him to methods of solving his own problems with a better chance of arriving at a logical conclusion, and to arouse in him a greater curiosity which may act as a spur to further investigation. With the exception of a few domesticated animals, plants come more prominently into the environment and form an overwhelming majority of the whole number of individuals.

Plants are more suitable for early experimenting for one reason because it may be carried on and keep unspoiled the natural reverence for living things which is inherent in the mind of every normal child. He shrinks from wounding, causing pain or taking the life of any animal. So also he does not like to handle its dead body. Plants may be badly treated, starved, mutilated or killed without that shock and revulsion which children feel toward a similar treatment accorded to animals. The bloom of poetic feeling is rubbed off all too soon from the child mind in its contact with the realities of the human struggle for existence.

In the second place, to put plants first is in accordance with genetic history. Plants were without doubt the earliest inhabitants of the world and they thus prepared the way for the more complex animal life which was to follow. The food supply of the world is of first interest to its living inhabitants so that after the air, earth, and sky with its life-giving sun, plants must have seemed of supreme importance to primeval man.

Since plants of some kind were the first inhabitants they might be expected to show primitive traits and exhibit the essential life-processes in a form more easily understood by the beginner. First among their exclusive characters is the power to manufacture food which process can be readily demonstrated in the green parts of plants. The storing of energy which takes place in this process is fundamental to the life-activity of all organisms and properly forms the starting point for the study of nutrition. Following this is the topic of digestion which can be most satisfactorily shown in a germinating seed.

Absorption and transfer of liquids through the agency of root hairs and the vascular system of plants is much more easily demonstrated and understood first in cells enclosed in cell walls. Growth and repair of living tissues is very readily studied from plant bodies. The germinating seedling is a most favorable object for the observation of growth and formation of new organs and the process of repair of wounds can be readily observed in almost

any tree, and if thought to be desirable, no violence is done to the finer feelings if wounds are made intentionally for the purpose of observing the method of repair.

The genesis of cells in the simpler plants is easily observed and the theory of cell lineage through mitosis is perhaps best taught through plants, which subject makes possible an explanation of heredity and the causes for the resemblances noticed in parents and offspring.

But it is in the explanation of the processes of reproduction, of the origin and meaning of sex, of race improvement through selection, the modification of form through the agency of environment, that plants lend themselves most readily and in a way which need not embarrass the most timid teacher who is fearful of the effects of sex instruction on the minds of the pupils. The pupils demand instruction in this direction either from properly constituted authority or from those who are always ready to give instruction.

This demand for enlightenment on sex phenomena is a normal one of the child mind and as necessary as instruction about any other function of the living organism. The basis for instruction in sex hygiene may well be laid in the study of green plants.

Special emphasis has thus far been laid on the adaptability of plants for explaining life phenomena, especially life processes, including those of reproduction. Plants have also certain advantages in the abundance of suitable material easily obtained; their comparative ease of handling in the laboratory; their ready response to changes of environment; and the ease with which they may be studied in their natural habitat recommends them to the teacher who may be handicapped by the lack of proper laboratory facilities.

There are also such a vast number of topics that are of intense human interest that appeal very strongly to children. Such simple exercises as planting seeds and watching for the plants to appear, the growth of mold on bread, the bacteria as agents of decay and in their relation to human disease, the fermentation of syrup by yeasts and the process of bread-making, the theory and practice of canning and preserving of fruits, the growth of mushrooms on wood and their relation to its decay, the proper way to plant seeds in the home garden or the ornamental flower bed are a few samples of topics that are of absorbing interest and because they touch on the life of the pupil they make a personal appeal and the science study seems to be really worth while.

You will doubtless say that what I have suggested is rather haphazard but it is meant only to show possibilities of selection of topics which will give at once valuable practical information, make a strong personal appeal to the interest of the child and also prepare the way to some extent for more special animal studies.

I do not intend to convey the impression that animal studies or rather the discussion of topics about animals should be excluded from this time when plant topics predominate. It will be found to be difficult, impossible in my own case, to exclude the discussion of related topics in other fields. Comparisons are inevitable and of the greatest advantage at times. When digestion is demonstrated in a sprouting seed the similar process may be explained in a brief and simple manner of digestion in the pupil's body. An easy parallel is drawn between the action of diastase and that of ptyalin, the respiration of sprouting seeds and that of human beings, the repair of a wound in a tree and the repair of a wound in flesh of an animal.

We must not forget that our divisions into botany, zoölogy, etc., are purely artificial and of use in pigeonholing our facts, and that such arbitrary divisions have not yet risen strongly in the consciousness of first or second year high school pupils. After once this unsystematic stage of thinking has passed over into that which seeks to arrange the facts of consciousness in accordance with great principles of classification, the priority of subjects in the course may then be decided by local circumstances or by personal preference.

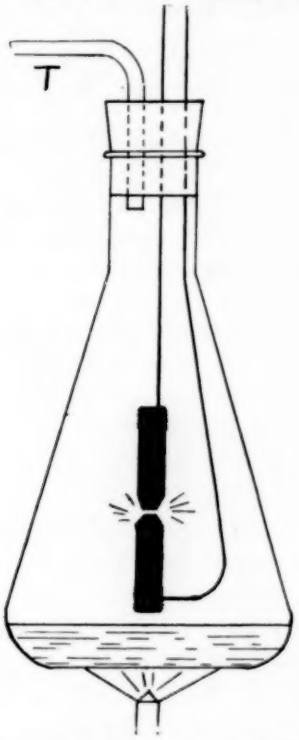
LECTURE EXPERIMENT FOR MANUFACTURE OF WATER-GAS.

By G. R. Robertson,
Polytechnic High School, Riverside, California.

Most laboratory manuals in chemistry do not suggest a lecture-table demonstration of the manufacture of water-gas, producer gas or oil-gas. The accompanying sketch shows a somewhat spectacular mode of accomplishing this aim. Although many teachers will not have gas furnaces, etc., a great number have the use of electric current supply.

As can be readily seen, the idea of the experiment is to produce a small electric arc in an atmosphere of steam. If the bottom of the Erlenmeyer flask be covered with a few cc. water, and the apparatus brought to a vigorous boil, the air will of course disap-

pear promptly. The single exit tube T leads to a common pneumatic trough, which soon shows the complete expulsion of air by



the knocking noise of condensing steam. If the two short arc carbons be touched to each other in the usual way, and an arc of 5 to 8 amperes started, quantities of water gas will be available at once, by the familiar action of white-hot carbon on water:

$$C \text{ plus } H_2O = CO \text{ plus } H_2.$$

In the western districts, where gas is made from petroleum exclusively, the apparatus may be used with kerosene, and afford a good illustration of the cracking of heavy hydrocarbon molecules. In this case a small flask should be used, and the whole contrivance placed in a spacious metal basin or receptacle to catch remains of possible wreckage.

The demonstrator must not start the arc until all air is expelled, and kerosene vapor alone is passing to the pneumatic trough. Such a warning should prevent any violent reaction.

The writer has not tried the device further in gas manufacture, but it is evident that a teacher can provide his advanced pupils with interesting problems, such as the action of the arc on an atmosphere of sulphur vapor, or upon carbon dioxide, illustrative of producer gas principles, etc.

NOTES ON THE SYSTEM OF CRYSTALLIZATION AND PROPER CUTTING OF THE SYNTHETIC CORUNDUM GEMS.[1]

By Frank B. Wade,

Shortridge High School, Indianapolis, Ind.

It is with some hesitation that I am attempting to present before the Physical Science Section of the Indiana Academy of Science a paper upon so technical a subject as the system of crystallization of the synthetic corundum gems, when my study of them has been but the recreation of one whose serious work lies in another direction.

It was while attempting to learn how to produce the best possible results in the way of richness and depth of color in cutting synthetic ruby that I made a study of the crystalline form of the rough ruby boules. The best lapidaries, in cutting natural ruby, long ago learned that, to produce the deepest and richest color it was necessary to lay the table of the cut stone parallel with the basal planes of the natural hexagonal crystal. Fortunately this method of cutting usually gave also the largest possible cut stone from the rough material, as the natural ruby has a tabular habit, with the greatest diameters parallel to the basal planes of the hexagonal prism.

Now—although the rough boule of synthetic ruby has the appearance of an amorphous mass—it is in reality crystalline, in fact a single crystal. Hence in cutting it proper regard should be had for its optical properties if the best results are to be obtained. The boules, however, although single crystals, have no well defined crystal faces or cleavages to reveal the system of crystallization or the direction of the optical axes.

It was in the endeavor to work out methods of determining these matters that I began a study of rough boules. I first studied the literature that was available upon the subject of artificial corundum gems, and for the sake of refreshing your memory in this direction I will briefly review that part of it which leads toward the subject of this paper.

The earlier workers attempted to obtain rubies by the fusion of alumina, either in glass or porcelain furnaces or by means of the oxyhydrogen blowpipe. M. Gaudin, in 1837, using the oxyhydrogen blowpipe to produce fusion, got tiny crystals of ruby when the melt was slowly cooled. These crystals, like those of nature, were in the hexagonal system, as shown by their external form. St. Clair de Ville and Caron produced rubies by fusion of alumina

[1] Proceedings of Indiana Academy of Science, page 164.

mixed with a little chromium oxide and, on one occasion they got both rubies and sapphires in the same crucible. These were very minute and had the usual crystal form of the natural stones. Fremy, by means of a high temperature continued for eight days, got rubies of the weight of one-third karat each. These also were regular crystals. No success was had by any of these earlier workers in obtaining rubies of commercial size.

About 1885 there began to come on the market, from Geneva, Switzerland, it is now said, some rubies which at first were sold as natural stones, but which, it developed later, were made by fusing together small natural rubies by means of the oxyhydrogen blowpipe. These rubies were generally bubbly, and the bubbles, unlike those in natural rubies, were spherical. There were also other signs by means of which the artificial character of these so-called "reconstructed" rubies might be detected. They were generally too low in specific gravity, probably owing to their bubbly character, and the color was a bit unnatural to the eye of an expert. They were, however, crystallized alumina. I have not had the opportunity of examining any of the drops thus produced while in the uncut condition, so that I am unable to speak in regard to their crystal structure. The cut stones are feebly double refracting and show dichroism like the natural rubies.

It was not long before the use of small natural rubies was discontinued and pure alumina mixed with a little chromium oxide was substituted. It was in 1904 that Verneuil published his method of producing true synthetic rubies by heating the above mixture in the flame of the oxyhydrogen blowpipe. The method employed by him in introducing the powdered material was exceedingly ingenious. A receptacle with a sieve bottom was constantly tapped by a mechanical tapper and the dust fell into the stream of oxygen and passed with it through the flame, which was directed vertically downward upon a support below. Upon this support the boule grew, first the slender stem, then, with proper manipulation of the flame the wider and wider dome, until, in some cases, the boule weighed over one hundred karats. The crystal character of these boules and of the blue and pink and white and yellow ones which later came to be made, forms the principal subject of this paper.

The blue color was obtained only after long study and experimentation on the part of Verneuil and an American assistant, Mr. I. H. Levin. They found that the attempt to blend cobalt as a colorant failed, the cobalt volatilizing or else floating out when the

boule cooled. Picard, in 1907, and Louis Paris, in 1908, succeeded in getting boules of a fine blue color by blending magnesia or lime with the alumina and adding cobalt. They were. however, not true sapphires. Some of these boules were sent to a friend of mine, an enthusiastic gem collector, Mr. Wm. H. Huse, of Manchester, N. H., and at his request I tested them and found that they were too low in specific gravity, too soft, and their system of crystallization was the regular or cubic system. They were singly refracting and showed no dichroism. They were, in fact, artificial spinels. Their color also was of too piercing a blue. This was afterwards remedied by adding a trace of chromium oxide, but then the color as seen by artificial light was unnatural.

In January, 1910, Verneuil and Levin succeeded in obtaining true sapphires by adding to 98 per cent of alumina 2 per cent of a mixture of ferric oxide and titanium oxide and keeping the boule in a reducing atmosphere. A paper in regard to these boules was read by Verneuil in 1910 before the French Academy. It quoted M. Wyrouboff, who examined them before they were submitted to the Academy. He said of them: They take the form of a single crystal which is uniaxial, optically negative and little birefractive, consequently having all the optical properties of the natural sapphires. Furthermore, their composition and crystalline construction must evidently lead to the conclusion that these stones are in every other respect identical with the natural sapphires. They even show the parti-colored effects like the natural stones."

In connection with this report of Wyrouboff I will quote here the report of Bauer, the great German gem expert, on the synthetic ruby boules. In a paper read before the German Chemical Society of Frankfort, A. M. Bauer says: "The ruby bulb, in spite of its round shape, shows a true crystalline formation. In specific weight, in hardness, as well as in all the optical properties, it is identical with the natural stone; in color and brilliancy it vies with the best specimens from the Orient."

Some of the new blue sapphires were sent to this country and were submitted to Prof. Alfred Moses of Columbia University, who says: "The chemical analysis shows the material submitted to be nearly pure alumina with, however, a measurable quantity of titanic oxide. The crystallographic and optical tests show that the material submitted is crystallized and that the cone by all tests is one homogeneous faceless (anhedral) crystal. The crystalline, optical and other characteristics determined are close-

ly those of natural sapphire. In the absence of natural faces or cleavages the crystalline system, as determined by the optical tests, may be either hexagonal or tetragonal. The parting figures point to the hexagonal system. Any two natural substances which were as nearly identical in chemical and crystallographic characters as the specimens submitted and natural sapphires would be called identical. The difference is one of origin."

While expert mineralogists are agreed that these synthetic products are identical with the natural in all their properties, yet the synthetic stones may in nearly every case be distinguished from the natural by one who is trained in seeking minute differences due to the difference in origin. As is now well known in the trade, the synthetic stones frequently contain bubbles which are always round or rounding in form. Natural corundum gems also frequently contain bubbles, but these are always bounded by crystal planes and are hence angular in appearance. Lacking the bubbles striæ may be seen in the synthetic stones, especially in the rubies, and these striæ, while parallel like those so often seen in natural stones, are, unlike the latter, not straight but curving. The color, too, in the case of the ruby, is not quite equal to that of the best natural stones, although in this respect I hope to show that the defect is probably due to improper cutting rather than to any real difference in the material. The synthetic rubies seem also to interfere with the passage of light through them to a greater extent than the natural stones when the latter are clear. This results in a sort of general illumination of the interior of the stone. One might say that the material was not optically a vacuum and that the Tyndall effect was produced. The flashes of light produced by total reflection from the rear facets of the stone are therefore seen against a background of faintly illuminated material instead of against a dark background, as in the natural ruby. This detracts from the beauty of the synthetic ruby somewhat, and it is this phenomenon I believe which enables an expert to tell by inspection without the aid of a lens whether a stone is a natural or a synthetic ruby. Some experts have claimed that they could tell by the touch alone whether a stone was a synthetic or a natural one. This difference I believe to be due to the very hasty manner in which the synthetic stones are cut. They are cut abroad so cheaply that they can be sold in America for less than the price per carat charged for cutting alone by the American lapidary. It is thus probably the inferior surface finish of the synthetic stone that reveals itself to the trained touch of the ex-

pert. I have carefully polished a specimen of synthetic ruby to determine this point, and while I can feel a difference between the synthetic stone of commerce and the natural stone, I am unable to distinguish any difference between my finely polished synthetic stone and a natural one.

I have shown that gem experts have decided that the boules of synthetic corundum gems are single crystals and that they crystallize either in the hexagonal or in the tetragonal system. Professor Moses of Columbia University said also that the parting figures suggested the hexagonal system. The experts also said that the crystals were anhedral or faceless. I wish now to add some evidence from my study of them that indicates that the boules are not altogether faceless, and then to advance evidence along two different lines to prove that the crystals *are* of the hexagonal system, as was indicated by the parting figures.

Observation of a considerable number of the boules shows that there is a flattening on one side of nearly every boule, and an optical study of the boules shows that this flattening is nearly parallel to the basal planes of the crystal. Viewed with the dichroiscope perpendicularly to the flattened place there is no dichroism. The depth of color, too, is greatest when viewed in this direction, and that would be true of natural ruby when viewed perpendicularly to the basal planes of the hexagonal prism. On grinding the surface parallel to the flattened place a slightly pearly effect is seen, and this surface thus produced is more difficult to polish than a surface that cuts across the grain in any other direction. This is generally true when working parallel to the cleavage of a natural crystal, and thus indicates that the flattened place on the boule represents the base of the prism. On this flattened face markings appear, indicating distortion of the edges of the layers of the material. There is a drawing down and curving of the edges of the layers as they cross the basal plane as though some force had distorted the layers as they arrived. These markings go far down toward the stem of the boule, indicating that the direction of crystallization is early determined. In a few boules the flattening is absent, and then I have found that the optical axis lies up and down the boule and that the top of the boule is flatter than in the other type. In such boules there is also evident a tendency toward forming a hexagonal prism with faces and angles roughly apparent. Where the flattening occurs on the side of the boule, which is the usual case, it does not form a perfect plane, being apparently interfered with—perhaps by the surface tension

of the semi-plastic mass. The longest horizontal diameter of the boules (they are made with the stem of the pear acting as a vertical support) is invariably parallel to the flattened face. On the side of the boule opposite to the flattened face there is sometimes another and smaller flattened face approximately parallel to the first. This, too, shows evidence of distortion of the lines representing the edges of the strata of accretion.

From what has been advanced in regard to these imperfectly developed basal faces I think that the term anhedral as used to describe the boule should be qualified. The boules are nearly anhedral, but not quite so. The forces of crystallization succeeded in forming a single crystal in spite of the adverse forces acting upon the boule, but they were unable to face up the crystal except imperfectly, as has been described.

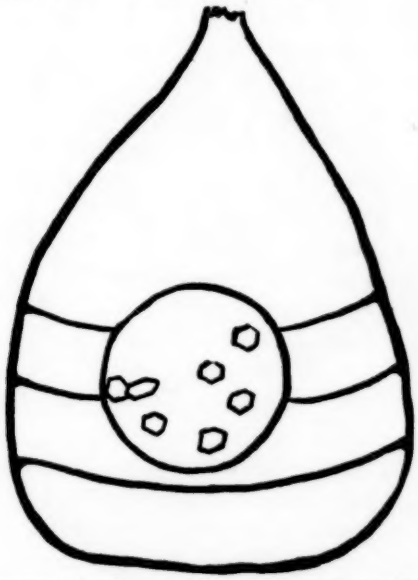


FIGURE 1A. RUBY VIEWED ON FLAT SIDE.

I will now pass to my next topic and offer evidence of the hexagonal character of the boules. On examining the flattened surfaces described above, by means of a compound microscope with a magnification of several hundred diameters, I found that by proper focusing I was able to trace the outlines of minute crystals which formed a species of frost work upon the surface of the boule. These crystals were all of similar orientation, and their orientation was nearly that of the boule itself. When viewed

perpendicularly to the flattened place on the boule the minute crystals had hexagonal forms (Figures I a and b). When viewed at right angles to the basal plane of the boule rectangular figures representing the edges of hexagonal plates were seen (Figures II a and b). The evident hexagonal form of these minute components of the crystal and their common orientation would seem to prove the hexagonal character of the boule on a crystallographic basis independently of the optical evidence.

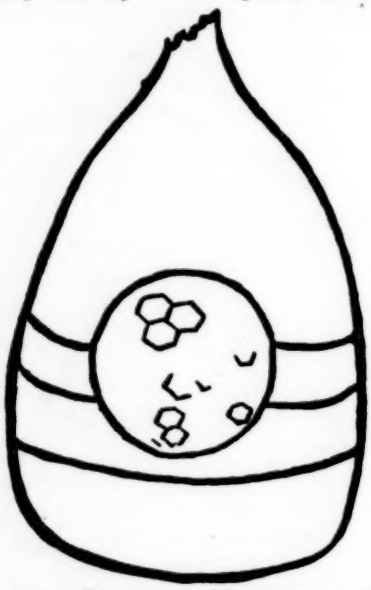


FIGURE 1B. YELLOW SAPPHIRE VIEWED ON FLATTENED SIDE.

I find also that by examining fractured surfaces of ruby boules with similar magnification (i. e., several hundred diameters) I can find sharp hexagonal cavities out of which hexagonal plates have been torn by the fracture as though there had been a species of molecular cleavage. This, too, would seem to confirm from a crystallographic basis the hexagonal structure of the boule.

As further evidence of this structure I find that in the case of a cabochon cut (smooth, convex upper surface) ruby which I myself cut from a fragment of a boule, I can plainly see a six-pointed star when viewed in direct sunlight or even when seen by the light of a single candle. This star effect is due to the presence in the material of microscopic bubbles, which produce somewhat the same effect as is produced by dust particles in a beam of light crossing a darkened room. The six-pointed character of the star

plainly indicates that the material has the hexagonal arrangement, as a tetragonal crystal under similar conditions would produce a cross rather than a six-pointed star.

Having, as I believe, sufficiently shown that—as would be expected from its resemblance to the corundum gems of nature—the artificial gem corundum forms single hexagonal crystals, I will now briefly indicate how practical advantage may be taken of this fact in the cutting of fine gems. The lapidary may now by mere inspection of the boule determine (by finding the flattened side) the location of the basal planes of the crystal. He should

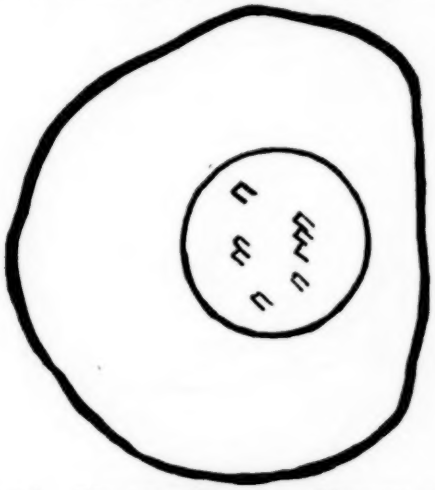


FIGURE 2A. YELLOW SAPPHIRE VIEWED ON TOP.

then cut the stone so that the finished product will have the table (large top facet) parallel to the flattened place on the boule (i. e., parallel to the basal planes of the crystal). Now a study of hundreds of cut stones of the synthetic type has shown that rarely if ever is one cut in accordance with this rule. Hence the fine deep color of the best specimens, of natural ruby, for example, is almost never equalled in the synthetic stones. By roughing out a ruby to nearly its finished form myself and then having a skilled lapidary facet it I have obtained a cut stone which I believe to be as deep and pure in color as the best of the natural stones. The synthetic stones of commerce seem to be cut as the boules break, and I find by opening boules myself that they nearly always break in such a direction that to cut the finished stone as it should be cut would waste two-thirds of the material; that is, a much greater spread in the finished stone may be had by cutting it as

it breaks rather than by cutting it as it should be cut to obtain the best color. I have tried to guide the break by using the natural edge of a diamond crystal so as to split the boule to favor the correct cutting, but the crack tends to turn around to the other side of the boule. I suspect that this is due to the following fact: As was said above, the flattened face of the boule is almost always parallel to the longer axis of the oval cross-section of the boule. Now natural ruby tends to cleave parallel to the basal planes, but only feebly so. The boules are under internal strain, somewhat

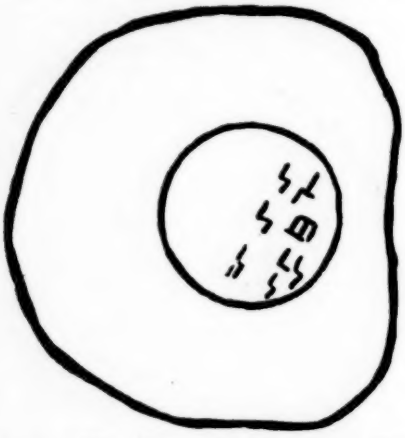


FIGURE 2B. RUBY VIEWED ON TOP.

as Prince Rupert's drops are, and when the surface of the boule is abraded even slightly, cracking follows and the strain is relieved. By cracking along the length of the boule at right angles to the plane of the flattened surface a smaller cross-section is made than would be made were the boule to split parallel to the basal planes. The natural cleavage is so feeble that I suspect the split follows the other direction as a line of least resistance. At any rate the boules split contrary to the natural cleavage and disadvantageously as regards cutting to produce the best color. By slitting with the diamond saw after the break has occurred the practical lapidary can still utilize the material advantageously and, keeping run of the position of the basal planes by means of the flattened place, can indicate in some manner upon the surfaces of the fragments where the table of the finished stone should be laid.

By giving due attention to this matter, synthetic rubies and sapphires equal in depth and purity of color to the fine stones

of nature can be produced. They will necessarily be sold at a higher price than most of those now on the market, but they will be worth more and should find a moderately large market among people of taste and discernment who have always loved to look upon fine natural sapphires and rubies, but who were unable to possess them at the prices commanded by the rare natural product.

A USEFUL LANTERN SLIDE SERVICE.

For ten years and more Cornell College, Iowa, has maintained as a special form of University Extension a lantern slide service in geology and physiography for the schools and colleges of the middle West. The college collection in these subjects numbers upwards of 4,000 slides and from it there have been selected 1,500 slides for this service. The following subjects are illustrated each with a set of fifty slides:

Weathering and Rock Sculpture (2).
Rivers, their Works and Ways (2).
The Travels of Water Underground (2).
The Arid Cycle.
Glaciers (2).
The Sea and Its Shores (2).
Earthquakes.
Movements of the Earth's Crust and Mountains.
Volcanoes.
Lakes, Their Origin and Life History.
The Grand Canyon of the Colorado, and other Canyons.
Niagara, and other Waterfalls.
The Desert and Its Flora.
Land Sculpture by Glaciers.
The Great Ice Age in North America.
Yosemite.
Norway, Its Fjords and Fjelds.
The World's Greatest Ice Fields.
Land Forms of Iowa.
Vesuvius and Its Buried Cities.
Mt. Pelle.
The Hawaiian Volcanoes.
Lava Plateaus of the Northwestern United States, Iceland, and India.
Yellowstone Park and Its Decadent Vulcanism.
Prehistoric Reptiles and Mammals.
Early Man.

Each set of slides is accompanied by a type-written manual explaining the features of the slides and suggesting their uses as class problems for sight-solution. The demand for the slides is such that it is necessary to order them at least one week in advance. All correspondence on the subject may be addressed to Prof. W. H. Norton, Mt. Vernon, Iowa.

PROBLEM DEPARTMENT.

By E. L. Brown,
Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

366. *Proposed by C. A. Perrigo, Dodge, Kansas.*

Factor $ab^3-a^3b+ac^3-a^3c+bc^3-b^3c$.

(From Hawkes, Luby, Touton's Second Course in Algebra, page 30.)

I. *Solution by Justina Staats, a pupil of High School, Dollar Bay, Mich.*

$$\begin{aligned} & ab^3-a^3b+ac^3-a^3c+bc^3-b^3c \\ &= ab(b^2-a^2)+c^3(a+b)-c(a^3+b^3) \\ &= (a+b)[ab^2-ba^2+c^3-ca^2+cab-cb^2] \\ &= (a+b)[c(c^2-b^2)+ab(c+b)-a^2(c+b)] \\ &= (a+b)(b+c)[c^2-bc+ab-a^2] \\ &= (a+b)(b+c)[(c^2-a^2)-b(c-a)] \\ &= (a+b)(b+c)(c-a)(a-b+c). \end{aligned}$$

II. *Solution by Gertrude L. Roper, Detroit, Mich, and R. T. McGregor, Coleville, California.*

The given expression vanishes for $a=-b$, $b=-c$, $c=a$.

Hence, by the factor theorem, $(a+b)$, $(b+c)$, $(c-a)$ are factors. By division the remaining linear factor is found to be $(a-b+c)$.

III. *Solution by H. C. Whitaker, Philadelphia, Pa.*

Set the expression equal to zero and proceed as if solving for a:

$$a(b^3+c^3)-a^2(b+c) = bc(b^2-c^2).$$

From which it is seen that $(b+c)$ is a factor.

Set the quotient equal to zero and proceed as if solving for b:

$$b^2(a-c)-bc(a-c) = a(a^2-c^2).$$

From which it is seen that $(a-c)$ is a factor.

Set the quotient equal to zero and solve for c:

$$c(b+a) = b^2-a^2.$$

From which it is seen that $(a+b)$ is a factor and $c=b-a$.

Hence the given expression $= (a+b)(b+c)(c-a)(a-b+c)$.

367. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Find the least number that 32 divides with a remainder of 25, 25 divides with a remainder of 19, and 19 divides with a remainder of 11.

I. *Solution by T. M. Blakslee, Ames, Iowa.*

Let the number be n and the quotients x, y, z.

$$n = 32x+25 = 25y+19 = 19z+11.$$

Therefore $$25y-19z = -8. \qquad (1)$$

and $$32x-19z = -14. \qquad (2)$$

Solving (1) and (2) in positive integers we have

$z = 7, 32, 57, 82, \ldots$ differing by 25.

and $z = 26, 58, 90, 122, \ldots$ differing by 32.

The smallest common value is $z = 282$. $\therefore n = 5369$.

II. *Solution by Guy Smith, Urbana, Ill.*

Let n equal the number.

Then $n = 32x+25 = 25y+19 = 19z+11$, where x, y, z are integers.

$$x = \frac{25y-6}{32} = \frac{19z-14}{32}.$$

Since y and z must be even, let $y = 2y_1$ and $z = 2z_1$.

$$\text{Then } x = \frac{25y_1-3}{16} = \frac{19z_1-7}{16}.$$

Since y_1 and z_1 must be odd, let $y_1 = 2y_2+1$ and $z_1 = 2z_2+1$.

$$\text{Then } x = \frac{25y_2+11}{8} = \frac{19z_2+6}{8}.$$

Since y_2 must be odd and z_2 even, let $y_2 = 2y_3+1$ and $z_2 = 2z_3$.

$$\text{Then } x = \frac{25y_3+18}{4} = \frac{19z_3+3}{4}.$$

Since y_3 must be even and z_3 odd, let $y_3 = 2y_4$ and $z_3 = 2z_4+1$.

$$\text{Then } x = \frac{25y_4+9}{2} = \frac{19z_4+11}{2}.$$

Since y_4 and z_4 must be odd, let $y_4 = 2y_5+1$ and $z_4 = 2z_5+1$.

$$\text{Then } x = 25y_5+17 = 19z_5+15,$$

$$\text{and } y_5 = \frac{19z_5-2}{25}$$

z_5 must be even and furthermore must be a number whose unit's digit is 8 to make y_5 an integer and therefore y an integer.

If $z_5 = 8$, $y_5 = 6$, then $x = 167$ and $n = 5369$.

This is the least number because 8 is the least value that z_5 may have.

III. *Solution by H. C. Whitaker, Philadelphia, Pa.*

Let $x =$ the required number and k, l, m, n, p whole numbers. Then by the conditions of the problem

$$x = 32m+25. \tag{1}$$

$$x = 25n+19. \tag{2}$$

$$x = 19p+11. \tag{3}$$

From (1) and (2) $\quad 32m-25n = -6. \tag{4}$

Reduce 25/32 to a continued fraction and take the last convergent but one; this equals $\frac{7}{9}$.

Hence 7 substituted for m and 9 for n would verify $32m-25n = -1$ and 6 times these values will verify (4), the least values being $42-25 = 17$ and $54-32 = 22$.

The value of x obtained by substituting in (1) or (2) is

$$x = 800k+569. \tag{5}$$

From (3) and (5) $800k-19p = -558$.

The last convergent but one of 19/800 is $\frac{9}{379}$ and $k = 19l+6$, $p = 800l+282$.

The value of x is $5369+15200l$.

IV. *Solution by Mary E. Caster, Harris, Iowa.*

Since 32 is contained in the required number with a remainder of 25, it is an odd number. And since all given remainders are odd, each odd divisor is contained an even number of times; that is, twice each odd divisor might be used with the same remainder.

Then since 50 will divide the number with a remainder of 19, the digit in unit's place is 9. The least number ending in 9 which leaves a remainder of 25 when divided by 32 is 89; and only by the addition of 160,

or some multiple of 160, can 9 be kept as the unit's digit. Then it is evident that the ten's digit must be an even number. And since in the second progression (19, 69, 119, 169, etc.) 6 is the only even number occurring as a digit in ten's place, 6 must be the required digit. That is, the last two digits of the required number form the number 69.

In the first progression (89, 249, 409, 569, etc.) 569 is the first term with the ending 69; and in order to maintain that ending, exact hundreds must be added each time; that is, 800, or some multiple of 800. It is evident, then, that the digit in hundred's place is, and must remain, odd.

That makes it possible in the second progression (19, 69, 119, 169, etc.) to use 200 as a difference, after 169 is reached. And after 569 is reached, this progression may be merged with the first.

In the third progression (11, 30, 49, etc.) 49 is the lowest term ending in 9. In order to produce a term ending in 69, such a multiple of 19 (or 190) as ends in 20, must be added. 190×8 (or 1520) $+49 = 1569$. This fulfills the conditions of ending in 69, and having an odd digit in hundred's place.

But since 1569 does not occur in the first progression, it is necessary to add 3800 as many times as, taken together with the difference between 1569 and 569, will produce a multiple of 800. $3800+1000 = 4800$, a multiple of 800.

$\therefore$ 1569+3800, or 5369, is the required number.

368. *Proposed by D. A. Lehman, Goshen, Indiana.*

Derive and prove a rule for multiplying two numbers, as 14×13, by the use of the table of twos only.

I. *Solution by Walter C. Eells, Tacoma, Wash., and M. G. Schucker, Pittsburg, Pa.*

Any number may be expressed in the binary scale as the sum of powers of two. Then the multiplication of any two numbers so expressed involves only adding exponents, finding powers of 2 (by table of twos only), and adding partial products.

Thus in the example given

$$14 = 2^3+2^2+2^1$$
$$13 = 2^3+2^2+2^0$$

$$14\times13 = 2^7+2^5+2^4+2^2+2 = 182.$$

II. *Solution by Editor.*

We may perform the operation by using the Russian Peasant Method of Multiplication. The operations employed in the use of this method are adding, doubling a number, and dividing by two, obtaining the exact or lower approximate quotient.

The method may be stated in the following rule, which is given in *The Mathematics Teacher*, September, 1912:

Having given the positive integers a and b, to multiply a by b write down $a\times b$; under a write the exact or lower quotient obtained by dividing it by 2; under this quotient write the quotient obtained by dividing it by 2, and so on, until you obtain the quotient 1.

Under b write its double, under this double its double, and so on, until you have as many numbers in the second column as in the first.

Next add the numbers in the second column which correspond to odd numbers in the first. The result will be the product of a and b.

Example:	13	×	14		14	×	13 (Omit)
	6		28 (Omit)		7		26
	3		56	or	3		52
	1		112		1		104
			182				182

370. *Proposed by Norman Anning, Chilliwack, B. C.*

A plane of unlimited extent is covered with uniform regular 12-gons packed as closely as possible. Compare the areas covered and uncovered.

I. *Solution by R. M. Mathews, Riverside, Calif., and D. J. da Silva, New York City.*

If r be the side of a regular 12-gon, then

$$\text{Area} = 12 \cdot r/2 \cdot r/2 \cdot \tan 75^\circ = 3r^2(2+\sqrt{3}).$$

If every alternate side of the 12-gon be extended, a regular hexagon will be formed, and three of these will completely cover the space about a point, thus every three adjacent 12-gons leave uncovered an equilateral triangle of side r. Corresponding to each 12-gon is one-third such triangle; and for each 12-gon there are six such one-thirds.

Hence, corresponding to each 12-gon there is an uncovered area of $\frac{r^2\sqrt{3}}{2}$.

Therefore,

$$\frac{\text{Area Covered}}{\text{Area Uncovered}} = \frac{3r^2(2+\sqrt{3})}{\frac{r^2\sqrt{3}}{2}} = \frac{4\sqrt{3}+6}{1} = 12.928 \text{ approximately.}$$

II. *Solution by M. G. Schucker, Pittsburg, Pa.*

Hexagons cover a surface completely. Dodecagons can be cut from hexagons with least waste by removing a triangle from each vertex so that its base will form one side of regular 12-gon. Let s be base and t side of this triangle; also r and a be radius and apothem of a hexagon. Then

$$\text{Area of hexagon} = 3r^2\sqrt{3}.$$

$$\text{Area of 12-gon} = 12as.$$

$$2t+s = r \text{ and } t = \frac{s\sqrt{3}}{3}.$$

$$\therefore s = r(2\sqrt{3}-3).$$

$$\therefore \text{area of 12-gon} = 18r^2(2-\sqrt{3}).$$

$$\text{Uncovered area} = \text{Hexagon}-\text{12-gon} = 3r^2\sqrt{3}-18r^2(2-\sqrt{3}).$$

$$\therefore \frac{\text{Covered Area}}{\text{Uncovered Area}} = \frac{\text{12-gon}}{\text{Hexagon}-\text{12-gon}} = 12.93 \text{ approximately.}$$

Credit for Solutions.

361. R. M. Mathews, N. P. Pandya of Baroda, India, I. L. Winckler. (3)

362. Vishnu D. Gokhale of Poona City, India, N. P. Pandya, I. L. Winckler. (3)

363. N. P. Pandya, I. L. Winckler. (2)

364. I. L. Winckler. (1)

366. Norman Anning, Katherine S. Arnold, Mary W. Clark, D. J. da Silva (2 solutions), Walter C. Eells, A. M. Harding (2 solutions), Charles E. Jenkins, Irvin E. Kline, R. M. Mathews, R. T. McGregor, H. C. McMillin, Margaret Moninger, Edward S. Mooney, C. A. Perrigo, D. H. Richert, Gertrude L. Roper, M. G. Schucker, Elmer Schuyler, Guy W. Smith, Marion Spilman, Justina Statts, Earl L. Thompson, Herbert C. Whitaker, Edward R. Wicklund. (26)

367. Norman Anning, T. M. Blakslee, Mary E. Caster, D. J. da Silva, Walter C. Eells, A. M. Harding, Daniel Kreth, Irvin E. Kline, R. M. Mathews, R. T. McGregor, H. C. McMillin, N. C. Rhoads, M. G. Schucker, Elmer Schuyler, Guy W. Smith, Herbert C. Whitaker. (16)

368. T. M. Blakslee, Walter C. Eells, M. G. Schucker. (3)
370. T. M. Blakslee, D. J. da Silva, R. M. Mathews, H. C. McMillin, M. G. Schucker. (5)

Total number of solutions, 59.

PROBLEMS FOR SOLUTION.

Algebra.

381. *Proposed by H. E. Trefethen, Waterville, Maine.*

Find the exact cube root of $648-\sqrt{418176}$.

382. *Proposed by F. Eugene Seymour, Trenton, N. J.*

Prove that if $a^2+b^2 = c^2$, then $ab(a^2-b^2) = 84m$.

Geometry.

383. *Proposed by W. T. Stratton, Manhattan, Kansas.*

In the triangle ABC, P is at a distance l and m from AC and AB respectively; P′ is at a distance l' and m' from AC and AB. If $l \cdot l' = m \cdot m'$, show that the angle PAC equals angle P′AB.

384. *Proposed by A. Heinz, Peking, China.*

Find the length of a line parallel to the bases of a trapezoid in terms of the bases, the ratio of the segments into which non-parallel sides are divided being known.

385. *Proposed by A. Heinz, Peking, China.*

Prove: In a truncated prism having a regular polygon of n sides as a cross section, the line passing through the center of this polygon, parallel to an edge and joining the non-parallel bases, is equal in length to the average of the n edges of the truncated prism; from this show that the volume of any truncated prism with regular polygon as cross section is: product of area of cross section into length of this centre line.

GRASSES AS WEEDS.

The quack grass *(Agropyrum repens)* probably fills every requirement in the farmer's definition of a weed, but there are three annual species which are fully as annoying to the gardener. These are the foxtail *(Setaria)*, the crab grass *(Panicum sanguinale)*, and the witch grass *(Panicum capillare)*. The efficient way in which these weeds conduct their annual campaign against the cultivated vegetables and flowers seems little short of intelligent. They do not come up early in spring to be cut down by the watchful gardener in the full swing of his spring enthusiasm for outdoor exercise; instead they wait so long before appearing that the novice may be deceived into thinking that he has vanquished them. But when the summer sun has baked the ground and the moisture has evaporated to the point where cultivated things begin to wilt at noonday, they appear, fresh, green and thrifty. They luxuriate in soil that is almost dust dry and their ability to get along with the minimum amount of moisture goes far toward making them invincible. How they manage to exist is more or less of a mystery. In all probability they have an exceedingly high osmotic pressure in their cells which enables them to extract moisture from such unfavorable surroundings.—*American Botanist.*

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

135. *Proposed by W. L. Bauchman, East St. Louis, Ill.*

Three complete turns of a rope are taken around a rough post and one end of the rope is held with a force of 100 lbs. weight. What force would be required at the other end in order to make it slip, if the coefficient of friction is 0.3?

136. *Proposed by F. E. Daniell, Terrell, Texas.*

Give a discussion of the following equation for finding the time in which a ball will roll down an inclined plane

$$t^2 = \frac{L^2}{\frac{1}{2}gH}$$

Where L is the length, H the height of the plane, t the time and g is gravity.

137. *Proposed by Theodore Cohen, Commercial High School, Brooklyn, New York.*

Manganese dioxide is allowed to react with a solution of hydrochloric acid. How would you teach this to a class as an oxidation-reduction reaction in electrical terms?

138. *Proposed by Lewis H. Fee, Everett, Wash.*

Assuming that a 32 c. p. carbon filament lamp takes 1 ampere at 110 volts and that a 40 watt Mazda will give the same candle power at the same voltage, how long will it take the Mazda lamp to pay for itself (cost 55¢) if it is operated 4 hours per day? Cost of electricity 12¢ per KW. hour.

139. *Proposed by John Metschl, Milwaukee, Wis.*

Supposing that a hole were bored completely through the center of the earth and that a stone be dropped into the hole—(a) Would the stone fall completely through the earth or only to the center? (b) Would the stone describe simple harmonic motion in the hole? (c) Would the stone have any kinetic energy the instant that it reached the center of the earth? Give reasons for each answer.

140. *Proposed by W. L. Hughes, Engineer, Cleveland, Ohio.*

Exhaust steam from a sodium sulphate condenser trap is free-exhausted at a pressure of 1 lb. through a 16″ orifice. What HP. is lost?

Answers and Solutions.

120. *Also solved by W. L. Baughman, East St. Louis, Ill., and H. C. McMillin, Washington, Kans.*

122. *From a Princeton Examination Paper.*

The specific heat of copper is 0.093. 362.8 grams of water are contained in a copper vessel whose mass is 400 grams. The water is at 15° C. Into

the cup are dropped 920 grams of a metal at 325° C. The mixture of metal and water come to 35°. Calculate the specific heat of the metal.

Solution by H. C. McMillin, Washington, Kans.

Heat given up = heat taken up.

$$920x(325-35) = 362.8(35-15)+400\cdot.093(35-15)$$

$$x = .029+\text{specific heat metal.}$$

123. *Also answered by H. C. McMillin, Washington, Kans.* Ans. 476.57 cc.

125. *Proposed by A. Bjorkland, Appleton, Wis.*

May the same bolt of lightning strike a building and at the same time kill stock in a field one-half mile distant?

Answered by R. C. Colwell, Geneva College, Beaver Falls, Pa.

When a bolt of lightning rushes from the clouds to the earth, the discharge is sometimes oscillatory. Hence a cloud will occasionally be found at lower potential than the earth. A discharge then takes place FROM the earth TO the cloud—this is usually called the "RETURN SHOCK." It was the return shock that killed the cattle. For a completer explanation, I refer to Flammarion's "Thunder and Lightning."

126. *Proposed by H. C. McMillin, Washington, Kansas.*

A man ascending in a balloon drops a stone when on a level with a church spire 128 feet high. The stone reaches the ground in 4 seconds. What was the balloon's vertical velocity?

Answer by James Friauf, Student, and T. Roy Hazelrigg, Teacher, Missoula County High School, Missoula, Mont.

Let t be the time for the body to fall down from its highest point.

Then $S = \frac{1}{2}gt^2$ = the space it falls.

Also $\frac{1}{2}gt^2-128$ = the distance it goes above the spire.

But since the time for a body projected upward to come to the highest point is the same as for the same body to fall then, since it takes 4 seconds for the entire flight it takes $(4-t)$ for the body to go from the spire to the highest point.

And $\frac{1}{2}g(4-t)^2$ = space the body goes above the spire.

Thus $\frac{1}{2}gt^2-128 = \frac{1}{2}g(4-t)^2$. (Using g as 32 feet.)

$16t^2-128 = 256-128t+16t^2$.

$128t = 384$.

$t = 3$, seconds for the body to fall from highest point.

$4-3 = 1$, second for the body to go to highest point from the spire.

But since the initial velocity is equal to the final velocity, then $V = gt =$ 32 times 1 = 32, feet/sec. Answer.

Also answered by Robert C. Colwell, Beaver Falls, Pa.; Fred M. Taylor, Vandalia, Ill.; Lewis H. Fee, Everett, Wash.; Clarence F. McCormick, Worcester, Mass.; A. G. Bowne, Cedar Rapids, Iowa.

128. *From Hale's Calculations of General Chemistry (Van Nostrand).*

A specimen of silver, containing 3 per cent copper, weighed 9.8 grams. After solution in nitric acid, an excess of sodium chloride was added to it. Calculate the weight of silver chloride precipitated. (Number 163, page 103.)

Solution by A. G. Bowne, Cedar Rapids, Iowa.

An equation for the first reaction is

$$Ag+2HNo_3 \rightarrow AgNo_3+H_2O+No_2$$

$$108+ \text{——} \rightarrow 170+ \text{——}$$

$\therefore$ 108g silver will yield 170g $AgNo_3$ and 97% of 9.8g or 9.51g wt. of silver in specimen will yield a proportionate amount.

$$108 : 170 = 9.51 : x$$

$$x = 14.97 \text{ } AgNo_3.$$

Equation for second reaction is $AgNo_3 + Nacl \rightarrow Agcl + NaNo_3$ 170+ ——→ 143.5+ ——

Since 170g $AgNo_3$ will yield 143.5g Agcl.

By proportion $14.97g : x = 170 : 143.5$.

$x = 12.64$g AgCl precipitated. Answer.

129. *From Millikan & Gale's Physics (Revised) page 196. (Ginn & Co.)*

It requires a force of 300 kilos to drive a given boat at a speed of 15 knots (25 km.). How much coal will be required to run this boat at this speed across a lake 300 km. wide, the efficiency of the engines being 7 per cent and the coal being of a grade to furnish 600 calories per gram?

Solution by Clarence McCormick, Worcester, Mass.

Force = 300 kilos = 300,000 gram-meters.

1 calorie = 427 gram-meters.

$\therefore \frac{300{,}000}{427}$ = No. of calories required to drive boat 1 meter.

$\frac{30{,}000}{427} \cdot 300{,}000 = \frac{9 \cdot 10^{10}}{427}$ = total number of calories required to drive boat across lake disregarding waste of engines.

$\frac{100}{7} \cdot \frac{9 \cdot 10^{10}}{427} = \frac{9 \cdot 10^{12}}{2989}$ = entire number of calories furnished by the coal.

$\frac{9 \cdot 10^{12}}{2989} \div 6000$ = grams of coal required.

$\therefore$ 501.8 kg. of coal are required.

Also solved by A. G. Bowne, Cedar Rapids, Iowa. Ans. 500.12 kgm.

A Correction.

From Mr. A. Bjorkland, the proposer of problem 115.

"Permit me to call your attention to the error in the solution of problem 115 as published in the January number of SCHOOL SCIENCE AND MATHEMATICS. The answer to the first part should have been 96 volts instead of 1536.

"While I do not remember the exact figures in the solution that I sent you, the published one does not seem at all familiar, and possibly it has been confused with some other solution. If so will you kindly make the correction."

The solution should have been published as follows:

$C = \frac{1}{2}$ ampere. $R = 16 \times 12 = 192$ ohms. $C = E/R$, hence $E = 96$ volts.

This error was also called to the attention of the Editor by Charles W. D. Parsons, Chicago, Ill.; Auguste J. Tête, New Orleans, La.; E. E. Wolfe, Pittsburgh, Pa.; C. O. Vogelin, Newark, N. J.

ARTICLES IN CURRENT PERIODICALS.

American Mathematical Monthly for January; *5548 Kenwood Ave., Chicago, Ill.; $2.00 per year:* "The Tactical Problem of Steiner," W. H. Bussey; "A Geometrical Discussion of the Regular Inscribed Heptagon," J. Q. McNatt; "A Theorem in Number Theory Connected with the Binomial Formula," D. N. Lehmer; "An Application of Partial Derivatives to the Ellipse," M. O. Tripp.

American Naturalist for February; *Garrison N. Y.; $4.00 per year, 40 cents a copy:* "Some New Varieties of Rats and Guinea-pigs and their Relations to Problems of Color Inheritance," Professor W. E. Castle; "'Dominant' and 'Recessive' Spotting in Mice," C. C. Little; "On Differential Mortality with Respect to Seed Weight Occurring in Field Cultures of Pisum sativum," Dr. J. Arthur Harris; "The Inheritance of a Recurring Somatic Variation in Variegated Ears of Maize," Professor R. A. Emerson; "Restoration of Edaphosaurus cruciger Cope," Professor E. C. Case.

Journal of Geography for February; *Madison, Wis.; $1.00 per year, 15 cents a copy:* "The Modern Point of View in Geography Teaching," Richard E. Dodge; "Leipzig—The Sum of Parallel Forces," Eugene Van Cleef; "Geographical Influences in the Development of Scandinavia," Frederick Homburg; "Suggestions on the Selection of Subject Matter in High School Geography," C. F. Knirk.

Mathematical Gazette for December; *G. Bell & Sons, Portugal St., Kingsway, London; six no., 9 s. per year, 1 s. 6 d. a copy:* "The Simple Pendulum," Sir G. Greenhill; "Note on Finding Prime Numbers," A. Gérardin; "The Teaching of Numerical Trigonometry," J. W. Mercer; "The Calculus as an Item in School Mathematics," C. S. Jackson; "The Teaching of Easy Calculus to Boys," W. Kniwles.

Nature-Study Review for January; *Ithaca, N. Y.; $1.00 per year, 15 cents a copy:* "Nature-Study and the Teaching of Elementary Agriculture," extracts from the President's address; "Astronomy as Nature-Study," E. A. Fath; "Physical Nature-Study" II, W. T. Skilling; "The Lay of the Land," J. G. Needham; "Poultry Work," Edwin H. Scott; "Baking Buns as Nature-Study," John Dearness; "Some Students' Work," furnished by Gilbert H. Trafton; "Should School Gardens Survive?" Arthur D. Cromwell.

Physical Review for January; *Ithaca, N. Y.; $6.00 per year, 50 cents a copy:* "The Physical Properties of Selenium," P. J. Nicholson; "Characteristics of Crystal Rectification," Alan E. Flowers; "Some Observations on Selective Reflection from Solutions in the Infra-red," A. K. Angstrom.

Popular Astronomy for February; *Northfield, Minn.; $3.00 per year, 15 cents a copy:*. "The Study of the Stars," Edward C. Pickering; "Conditions on Jupiter in 1913" (with Plate V), A. Thos. G. Apple; "Mars with a Five-Inch Telescope" (with Plate VI), D. Henry Scarlett; "The North Pole," William F. Rigge; "A Wrong Attitude in Amateur Astronomy," Frederick C. Leonard; "Report of the American Meteor Society," Charles P. Oliver; "Monthly Report on Mars" No. 2, William H. Pickering; "Partial Eclipse of the Moon, March 11, 1914," William F. Rigge.

Psychological Clinic for January; *Woodland Ave. and 36th St., Philadelphia; $1.50 per year, 20 cents a copy:* "Shall Elective Courses Be Established in the Seventh and Eighth Grades of the Elementary School?" I. E. Goldwasser; "Physiological Age and School Standing," Irving King.

School Review for February; *University of Chicago Press, $1.50 per year, 15 cents a copy:* "Phillips Academy, Andover, Massachusetts," Claude M. Fuess; "The Distribution of High-School Graduates in Iowa," H. Edwin Mitchell; "A Plan for Testing Methods of Teaching Secondary Mathematics," G. W. Myers; "How Can Physical Training Be Made of Greatest Value to the High School Boy," W. L. Childs.

School World for January; *Macmillan and Company, London, Eng.; 7 s. 6 d. per year, 6 p. a copy:* "The Teachers' Register," T. Raymont; "Generalized Arithmetic," J. M. Child; "Class Teaching Through Partnerships," Norman MacMunn; "A Counterblast Against Vocationism," Frank J. Adkins; "The Use of the Projection Lantern in Teaching," George H. Rydall; "Commercial Education in Secondary Schools."

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 8; *Otto Salle, Berlin W, 57, Germany; M. 4.— per year, 60 Pf. a copy:* "Das geschichtliche Element im mathematisch-naturwissenschaftlichen Unterricht," Gen. Hofrat Dr. S. Günther; "Eine Beziehung am Kegelschnitt," B. Kerst; "Bemerkungen über einen geometrischen Satz," Prof. Dr. v Vieth; "Zur Napoleonsaufgabe," Prof. Dr. Krüger.

REPORT OF THE WINTER MEETINGS OF "THE SOUTHERN CALIFORNIA SCIENCE AND MATHEMATICS ASSOCIATION."

The regular winter meeting of The Southern California Science and Mathematics Association was held December 6th at Santa Monica, one of the famous seaside towns of the Pacific Coast. The sessions were in the new Polytechnic High School building which is famous for its magnificent view of the Pacific whose waves lap the shore but a short distance away.

The general session convened at 10 o'clock a. m. and was opeend by music furnished by the High School Girls Glee Club. Prof. J. E. McKnown, principal of the high school, welcomed the association to the city and was followed by music from the Boys Glee Club.

Dr. Walter V. Brem, professor of Pathology and Bacteriology in the University of Southern California, Los Angeles, then gave an address on "The Philosophy, Cause and Prevention of Disease." This was followed by an address on "Mercantile Efficiency as Applied to Education" delivered by Mr. Otto Buehrman. The general business meeting was held at the close of the morning session at which the officers of the Association were elected. The noon hour was devoted to a luncheon in the Cafeteria and the inspection of buildings.

At 1:30 o'clock p. m. the various sections met for the purpose of transacting business and election of officers for the ensuing year. The following officers were chosen:

GENERAL OFFICERS.

President—A. A. Hummel, State Normal School, Los Angeles, Cal.
Vice President—Prof. Russell, Ponoma College, Claremont, Cal.
Secretary-Treasurer—E. H. Barker—Polytechnic High School, Los Angeles, Cal.

BIOLOGY SECTION.

Chairman—J. H. Whitely, Manual Arts High School, Los Angeles, Cal.
Secretary—L. W. Welch, Polytechnic High School, Long Beach, Cal.

EARTH SCIENCE SECTION.

Chairman—H. T. Clifton, Pasadena High School, Pasadena, Calif.
Secretary—Grace M. Abbott, Polytechnic High School, Venice, Cal.

MATHEMATICS SECTION.

Chairman—W. W. Keyes, Hollywood High School, Hollywood, Cal.
Secretary—Ida I. Jones, Manual Arts High School, Los Angeles, Cal.

PHYSICS AND CHEMISTRY SECTION.

Chairman—H. L. Twining, Polytechnic High School, Los Angeles, Cal.
Secretary—M. L. Fluckey, Pomona High School, Pomona, Cal.

On this occasion the Earth Science and Mathematics Sections only, held meetings. The former was called to order by H. C. Van Buskirk, President of the General Association. The first number on the program was an address, "Geology as Applied to Mining in California," by Arthur B. Call, Consulting Engineer. Mr. Call presented in a most interesting manner the cause and great value of California mining interests, pointing out many of the difficulties experienced by the engineer in locating ore deposits.

This address was followed by a paper read by Howard J. Lucus of Throop College of Technology on "Porto Rico from a Chemist's Note Book." The Mathematics Section was presided over by the Chairman, E. H. Barker, of the Polytechnic High School, Los Angeles, Cal. Two pa-

pers were presented in this section, the first on "Type Forms" by W. W. Keyes of the Hollywood High School and the second on "Formulas, Their Evolution and Application" by H. L. Twining, Head of Department of Physics Polytechnic High School.

The December meeting was regarded as a success in every way and especially from the interest its members are taking in the science work of the day.

This meeting, however, is but a fraction of the work the Association has done recently. The Southern Branch of the State Teachers Association asked the Science Association to furnish a number of programs for the week beginning December 5th to be held in Los Angeles. This was done and the meetings had a marked degree of success.

The Wednesday afternoon program consisted of two addresses, the first by Dr. F. H. Sears on "Mount Wilson Solar Observatory" and the second on "How to Save Time in the Library" by W. A. Fiske, Director of Chaffey Library Foundation, Ontario, Cal.

On Thursday afternoon extensive and interesting programs were carried out by the different sections as follow:

BIOLOGY SECTION.

This Section was held in the State Normal School Auditorium and was in charge of John H. Whitely, of the Manual Arts High School. The following program was carried out:

"The Course in Biology in Pasadena High School"—Miss Mabel Peirson.

"The Biological Basis of Sex in Teaching Physiology"—A. A. Hummel, State Normal School.

"Fossils of the Mammoth Animals of Rancho LaBrea" (Illustrated)—J. Z. Gilbert, Los Angeles High School.

EARTH SCIENCE SECTION.

Miss Agnes Ralph of the Orange High School, had charge of this meeting and the following program was rendered:

"Geology of California Oil Fields" (Illustrated)—Harry R. Johnson, Consulting Geologist.

"Geological Formation of Southern California"—Ernest Behr.

"Fossils of the Mammoth Animals of Rancho LaBrea" (Illustrated)—J. Z. Gilbert.

This last illustrated lecture was given with the Biology Section at 3 o'clock p. m. in the Normal School Auditorium.

MATHEMATICS SECTION.

The Mathematics Section held an interesting meeting in the Polytechnic High School and was presided over by E. H. Barker, Chairman.

The following program was carried out:

"Essentials in Mathematics"—John S. Goldthwaite, Department of Mathematics, Lincoln High School, Los Angeles.

"Household Arithmetic for Girls"—Miss Ida I. Jones, Manual Arts High School Los Angeles.

"Intermediate High School Algebra"—Miss Lulu Moorman, Sentous Intermediate High School, Los Angeles.

"The Use of Tables in Computation"—H. C. Van Buskirk, Throop College of Technology, Pasadena, Cal.

Interesting discussions followed these papers and it was agreed by all that the meeting was one of importance.

PHYSICS AND CHEMISTRY SECTION.

This Section was held in the Polytechnic High School, Los Angeles,

and was called to order by the Chairman, C. M. Wescott of the Hollywood High School. The following symposium was carried out by members previously appointed to lead in the discussions of the various topics:

General topics: How can Physics and Chemistry be made more real to the Pupil?

1. Recent books or magazine articles of value to teachers or pupils in Physics.

2. Recent books or magazine articles of value to teachers or pupils in Chemistry.

3. Physics and Chemistry of the Home for Girls.

4. New Apparatus of special merit for Physics, preferably Commercial Articles, and new kinks in Physics Laboratory, or Lecture Table Practice.

5. New Apparatus of special merit for use in Chemistry, and new kinks in Chemistry Laboratory, or Lecture Table Practice.

The work of the Science Association on Friday afternoon consisted of excursions to various points of interest. About one hundred and fifty members of the Earth Science and Biology Sections chartered sight-seeing conveyances and visited Rancho LaBrea, the burying grounds of the Mammoth Quartenary animals, after which they went to the Agricultural Park Museum to view the vast collection of fossil remains that has already been exhumed from LaBrea.

The Physics and Chemistry Sections made three important and interesting trips. The first was to the Los Angeles Creamery Co., where all the processes involved in the preparation of their famous "Fer-Ma-lac," and the handling and distribution of ten thousand gallons of milk a day, were most interestingly set forth by competent guides to about two hundred persons who took the trip.

The next visit was to the Bishop Company where millions of pounds of the choicest candies and one hundred and fifty brands of delicate cakes and crackers, many of which would almost melt in the mouth, are turned out by experienced and competent workmen.

The wee hours of the afternoon had now come, and many returned to the city while a large number still remained to visit the Union Ice Companies plant and were here entertained for an hour or more.

The Southern California Science and Mathematics Association is now five years old. The initial plans for its organization were laid by the writer during the summer of 1908 and on the eighteenth day of November of that year twenty-five interested Science men met in the Chamber of Commerce building in Los Angeles and soon effected its organization.

The first meeting was held December 4th at Occidental College, Los Angeles, and from that time two regular meetings each year have been held, one in December and the other in April.

From one to two additional meetings, or excursions, have been carried out by the various Sections of the Association each year.

The Earth Science Section has been especially active in this respect. Trips have been made in the recent past to the Pecten beds in Orange County, to the burning oil shales in Pulgas Canyon, to the oil fields in the Santa Susanna region and on one occasion a boat was chartered and a visit made to the serpentine quarries and other mineral deposits on Cataline Island thirty miles at sea.

In view of its present activities the future has great things in store for the Association and its members are intense in their interest, and determination to accomplish the best results in all they undertake.

W. A. FISKE.

MINUTES OF THE MATHEMATICS SECTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

At the thirteenth annual meeting, the Mathematics Section of the Central Association of Science and Mathematics Teachers held two meeting, Friday and Saturday, November 28 and 29, 1913, at the East High School, Des Moines, Iowa.

Friday Afternoon Session.

The first session was held Friday afternoon, with the Chairman, Mr. Charles W. Newhall, presiding. The Secretary read the minutes of the 1912 meeting, which were approved. The Treasurer's report was accepted.

The Chairman appointed the following Nominating Committee:

1. Prof. H. E. Cobb.
2. Miss E. J. Fordyce.
3. Mr. Wm. E. Beck.

After this brief business meeting, Mr. R. L. Short gave the report of the Committee on Vocational Mathematics. This report is a preliminary one, in which a survey of the conditions is made and tendencies noted. Differentiation of classes and sexes is suggested and mathematics teachers are warned to leave the teaching of shop problems to the shop teacher.

The administrative change to the plan of six years for the elementary work and six years of the secondary would solve many of the pedagogical difficulties.

A course in vocational mathematics should cover the fundamental operations of algebra, including operations in fractional and quadratic quantities, the fundamental theorems of plane geometry, the trigonometry of the right triangle, and a solution of various types of algebraic formulæ.

Unification of mathematics is considered essential.

The first discussion of the report from the point of view of the "College and College Preparation" was given by Prof. Arthur G. Smith of the State University of Iowa.

Prof. Smith was in entire agreement with most of the fundamental suggestions of the report, but his closer scrutiny of some of the arguments was very illuminating.

He claimed that differentiation would be desirable if the student in the high school knew what his future life would be. He showed how impossible differentiation would be in most high schools because of the small number of pupils in the classes.

Our schools must teach their pupils to live, but it will not be by pretending to give them a ready reckoner for the mechanical solution of life's problems, but by teaching them to use their brains; and by reason and common sense solve the problems that arise in daily life.

In commenting on the "college demands and hindrances," Professor Smith claimed that the colleges demanded no more from the high school than the high school did from the elementary school.

He agreed that the teaching of fundamentals is what is needed; but that disagreement might come in interpreting that word. His belief is that mathematics is mathematics; and there is no such thing as engineering mathematics, college mathematics, vocational mathematics, so far as the elementary part of the work is concerned. It is when we come to the application of mathematics that we have vocational mathematics.

Mr. W. Lee Jordan of Des Moines gave the second discussion from the standpoint of the general high school. He spoke of the tendency to get

into a rut, and objected to the pessimistic attitude of the first part of the report. He thinks changes are being made as rapidly as they ought to be. He commended the idea of teaching fundamentals; and said that the general high school has so many things to teach that it cannot do very much in the many vocations. He quoted from the report of the International Commission to show that the main purpose in teaching mathematics is not utilitarian. Mr. Swartz, Mr. Terry, and Miss Lynch were not present, hence their reports were omitted.

Mr. Perry D. Smith gave an interesting talk on the work done in the Francis W. Parker School of Chicago. He introduces geometry with a study of ancient mathematical instruments. These are made by pupils outside of class. He exhibited some of the instruments and told of their use. Among these were:

1. The quadrant—used for finding the altitude of the sun and stars; and for measuring unknown distances.
2. The isosceles triangle with a plumb line from the vertex angle.
3. A mirror.
4. A cross staff six feet long. This was used by Columbus to find the altitude of the sun.
5. A plane table.
6. A plane table with a level and sights, to take the place of a transit.
7. Geometric square, for unknown distances.
8. Alidade, for heights.

Mr. A. W. Cavanaugh described the work done in Lewis Institute, in the regular classes, the evening classes, and the co-operative courses.

This was followed by an informal discussion in which many members took part.

The report of the committee was accepted and the committee continued.

Since Mr. Short declined to be chairman for the next year, it was moved and carried that Mr. Kenneth G. Smith, of Iowa, be made chairman of the committee.

Seventy-eight were present at the afternoon session.

SATURDAY MORNING SESSION.

Mr. C. E. Comstock distributed copies of report of the Committee on Examinations and Results.

He showed the great need of more scientific measurement of abilities and achievements; gave certain laws of teaching; he illustrated various types of examinations, including association tests, inference tests, test for clear and concise expression of thought, and Ebbingham's tests; he discussed standards and scales of merit symbols for designating measures of merit, tests for efficiency of methods, and tests for certain algebraic abilities.

Copies of this report may be had by writing to Mr. Comstock or to the Secretary.

Mrs. Jane Pollock Anderson of Kenilworth, Illinois, gave a very interesting paper on "The Traditional Examinations in Mathematics." She listed a number of reasons why final examinations are claimed to have a rightful place in our teaching, and in each case showed that the desired end could be attained in other ways better than by examinations. But, even if this were not so, she claimed that examinations are a failure because of the impossibility of making out fair questions; the impossibility of marking fairly and accurately.

She pointed out certain positive evils and many injustices of examina-

tions. At best, it is a matter of human opinion, so why not leave the question of passing to the teacher's judgment? This leaves the teacher free to train the pupil in thinking, rather than in mechanical processes. This paper is published in full in the March number of SCHOOL SCIENCE AND MATHEMATICS.

Dr. Florian Cajori gave a most scholarly paper on "A New Marking System and Means of Measuring Mathematical Abilities."

He showed that the Binet-Simon tests were not suited for use in higher schools; that the present examination system is unreliable and inaccurate; and that the value of a syllabus of essentials is overestimated.

The scheme presented for measuring mathematical abilities resolves itself into two parts, as follows:

1. A formula for "arranging" students in order of ability; that is, for determining the relative positions of the members of a class, so as to establish the order of merit, or the rank of each individual in the group. This formula furnishes also preliminary estimates of ability.
2. A revision of these preliminary estimates, so as to supplant them by an absolute standard.

The mathematics pupil is measured in three ways:

1. By memory tests—
   (a) in daily work.....M_a
   (b) in examinations .....M_b
2. By original exercises—
   (a) in daily work.....O_a
   (b) in examinations .....O_b
3. By diligence shown or tenacity.....D

These marks are combined to give the preliminary mark according to the following formula:

$$\text{Preliminary mark} = \frac{Ma+rMb+sOa+tOb+uD}{1+r+s+t+u},$$

where r, s, t, and u are coefficients determining relative weights given to daily work and examinations. A conservative estimate would be to take $s = 1$, $r = t = u = \frac{1}{2}$.

After the relative place or rank of students in a class has been determined, we proceed to determine their marks, on an absolute scale. In this it was assumed that the gaussian curve or normal curve of distribution could be used.

Following this Dr. Cajori gave a table showing the average differential abilities of pupils chosen at random, for classes of 20, 30, 40, 50 and 100.

This table, as well as the complete paper, will be published in the March issue of SCHOOL SCIENCE AND MATHEMATICS and in the Proceedings.

The class is divided into five groups:

POOR.	INFERIOR.	MEDIUM.	SUPERIOR.	EXCELLENT.
Below -1.5	-1.5 to $-.5+$	$-.5$ to $+.5$	$+.5$ to $+1.5$	Above $+1.5$

The advantages of the system are:

1. It rests on correct statistical theory.
2. The groups called superior, medium, and inferior, cover equal ranges of ability. These ranges are constant, no matter what the size of the class. Neither the top group called excellent, nor the bottom one called poor, has a fixed extreme limit.
3. It tends to eliminate the personal equation of the examiner.
4. The method is absolute, except in the determination of the devia-

tions of the marks of a class from the average marks of classes of that size.

Miss Long, Miss Sykes, Miss Graham, Mr. Perry Smith, and others entered into a lively and interesting discussion of the papers of the morning.

Prof. Cobb presented the following report of the Nominating Committee:

Mr. H. L. Terry, of Madison, Wis., for Chairman.

Miss Edith Long, of Lincoln, Neb., for Vice Chairman.

Miss E. Marie Gugle, of Toledo, Ohio, for Secretary.

On a motion by Mr. Comstock, the report was accepted and the chairman of the committee cast the ballot for the officers nominated.

On a motion by Miss Sykes, the report of the Committee on Results was received and the committee continued. Then the meeting was adjourned.

Sixty-five were present at the morning session.

MARIE GUGLE, *Secretary*, Toledo, Ohio.

STANDARD SCIENTIFIC COMPANY.

A distinct departure in catalog making has just been effected by the STANDARD SCIENTIFIC COMPANY of New York. We refer particularly to their new publication entitled: "HAND-BOOK OF STUDENT APPARATUS, WITH A CLASSIFIED LIST OF THE EXPERIMENTS OUTLINED IN MODERN LABORATORY COURSES AND MANUALS OF PHYSICS."

The book presents an unusually attractive appearance and embodies the highest qualities of composition and press work. Its size 4¾x7 inches conforms to that now generally adopted for laboratory manuals. This together with the rounded corners adapt it equally well for either the pocket, the desk, or the library shelf.

The publishers of the Hand-Book have included practically all of the experiments outlined in the standard courses and laboratory manuals of Physics for Secondary Schools. Under the title of each experiment is given a complete list of the apparatus necessary for performing that experiment—according to the methods used by various authorities—together with catalog numbers, descriptions, and price of each piece of apparatus. This makes it a convenient and definite reference list for use in the selection of a complete equipment according to some particular course or manual, or for any individual experiment which may be found desirable. Reference lists to the experiment numbers in the various laboratory manuals render valuable aid to teachers in looking up the methods described by the different authors.

In the latter part of the Hand-Book is given a list of courses and manuals with cross-references between the experiments in each course or manual, and the corresponding numbers assigned to each experiment in the Hand-Book. Thus a selection of apparatus adapted to any of these courses, or to a selective course embodying the best methods and apparatus regardless of author, may be made with the greatest convenience.

All in all, we consider this Hand-Book one of the most successful attempts at furnishing science teachers with a catalog which will be of real assistance in planning science courses and selecting the necessary equipment. A copy of this Hand-Book can be obtained by writing to the Standard Scientific Company, 147-153 Waverly Place, New York City.

BOOKS RECEIVED.

Pathogenic Micro-Organisms, by Ward J. MacNeal, New York, Post-Graduate Medical School. Pages xxi+462. 14x20 cm. Cloth. 1914. $2.25 net. P. Blakiston's Son & Company, Philadelphia.

Chemisches Experimentierbuch, Zweiter Teil, von Dr. Karl Scheid. Pages viii+207. 14x20 cm. Cloth. 1914. M. 3.—. B. G. Teubner in Leipzig.

Molecules Atomes et Notations Chimiques. Pages xii+116. 12.5x19.5 cm. Paper. 1913. Librairie Armand, Colin, Paris.

L'air L'acide Carbonique et L'eau. Pages xi+104. 12.5x19.5 cm. Paper. 1913. Librairie Armand, Colin, Paris.

South America, A Supplementary Geography, by James F. Chamberlain, State Normal School, Los Angeles, and Arthur H. Chamberlain, Throop Institute, Pasadena, Cal. Pages ix+189. 13x19 cm. 1913. 65 cents. The Macmillan Company, New York.

Industrial Organic Analysis, by Paul S. Arup. Pages xii+340. 13x19 cm. Cloth. 1913. $2.25 net. P. Blakiston's Son & Co., Philadelphia.

Practical Mathematics, by Norman W. M'Lachlan, Liverpool. Pages viii+184. 12x19 cm. Cloth. 1913. 80 cents. Longmans, Green & Co., New York.

Biology of Sex for Parents and Teachers, by T. W. Galloway, James Millikin University. Pages ix+105. 13x19 cm. Cloth. 1913. D. C. Heath & Company, Boston.

Wesen und Wert des Naturwissenschaftlichen Unterrichtes neue untersuchungen einer alten frage, von George Kerschensteiner. Pages xii+141. 14x22. Paper. 1913. M. 3.6. B. G. Teubner in Leipzig.

Foods and Household Management, a text-book of the Household Arts, by Helen Kinne and Anna M. Cooley, Teachers College, Columbia University. Pages xiii+401. 13x19 cm. Cloth. 1914. $1.10. The Macmillan Company, New York.

Introduction to Botany, by Joseph Y. Bergen and Otis W. Caldwell, University of Chicago. Pages vii+368. 13.5x20 cm. Cloth. 1914. $1.15. Ginn & Company, Boston.

Oral English in Secondary Schools, by William P. Smith, Stuyvesant High School, New York City. Pages xiv+358. 13.5x19.5 cm. Cloth. 1913. $1.00. The Macmillan Company, New York.

Models to Illustrate the Foundation of Mathematics, by C. Elliott. Pages viii+116. 14x21.5 cm. Paper. 1914. 2 s. 6 d. net. Lindsay & Co., 17 Blackfriars Street, Edinburgh.

Journal of the Proceedings and Addresses of the Fifty-first Meeting of the National Education Association. Pages xi+827. 16x23.5 cm. Cloth. 1913. Published by the Association, Ann Arbor, Mich.

Introduction to Botany, by J. Y. Bergen, and Otis W. Caldwell, Dean of University College, University of Chicago. Pages vii+368. 13x19.5 cm. Cloth. 1914. $1.15. Ginn & Company, Boston.

Chemistry and its Relation to Daily Life, by Kahlenberg and Hart. The Macmillan Campany, New York.

BOOK REVIEWS.

First Course in Algebra, by William B. Fite, Professor of Mathematics in Columbia University. Pages vii+285. 13x19 cm. 1913. D. C. Heath & Company, Boston.

The introductory chapter avoids definitions and acquaints the beginner with the use of algebra by a large number of simple exercises and prob-

lems. Throughout the book there is a good collection of easy problems for oral work in the class-room and for written work. There are many new problems which connect the subject with geometry, physics, and every-day life. The graphical work is confined to the representation and solution of equations.

In choice of material and methods of presentation the author has kept well within the needs and comprehension of first-year pupils, and the book will no doubt be found in actual practice to be very satisfactory and efficient. H. E. C.

Geheimnisse der Rechenkünstler, by Dr. Philipp Maennchen. Pages 48. 12x18 cm. 1913. Price M.—.80.

Beispiele zur Geschichte der Mathematik. II Teil, by Dr. Alexander Witting and Dr. Martin Gebhardt. Pages 61. 12x18 cm. 1913. Price M.—.80. B. G. Teubner, Leipzig.

These little volumes are from the Mathematische Bibliothek, edited by Dr. W. Lietzmann and Dr. A. Witting. Fifteen volumes have already been issued and several others are in preparation. The list of titles shows that several of these volumes are of possible interest to high-school teachers and pupils.

In *Geheimnisse der Rechenkünstler* the methods of the lightning calculator in extracting cube, fifth, seventh, and other roots are explained. Other topics are: Bestimmung des Osterdatums, Die "denkenden" Rosse von Elberfeld, Das Ferrolsche Rechenverfahren, Die Neuner- und Elferprobe, and Der kleine Fermatsche Staz.

Some of the topics in *Beispiele zur Geschichte der Mathematik* are: Certain problems in geometry and algebra translated from Arabic and Latin, an example of an Arabic sexagesimal division of the fifteenth century, examples from the "Feldmesskunst" of Leonardo de Cremona (1400), early symbols for the unknown quantity, extract from a letter of Regiomontanus (1463), "Underweysung der messung . . . " by Albrecht Dürer (1525), extracts and examples from the arithmetic of Michael Stifel (1544), expression of irrational roots, J. Scheubel (1545), table of Pythagoras from V. Strigel (1563). H. E. C.

Analytic Geometry, by Alexander Ziwet, Professor of Mathematics, and Louis A. Hopkins, Instructor in Mathematics, The University of Michigan. Pages viii+369. 13x19 cm. Price, $1.60. 1913. The Macmillan Company, New York.

This *Analytic Geometry and Principles of Algebra* comes pretty near solving the perplexing problem of making the course in college algebra worth while. It combines with analytic geometry the most important topics of algebra, with the exception of infinite series. This subject can best be studied in calculus where immediate application is made. The combination of topics is skillfully worked out and it seems a natural mode of procedure to unite topics that depend upon or are closely connected with geometric representation.

The fruits of Professor Ziwet's long and distinguished labors in mechanics and applied mathematics are seen in the large number of concrete problems and applications throughout the book. The idea of a derivative is developed in connection with the discussion of algebraic equations and in finding the slope of curves. Some of the more important higher plane curves are discussed, and empirical equations are treated with sufficient fullness to give the student a working knowledge of this valuable subject. Eighty pages are given to solid analytic geometry. It is to be hoped that this book will hasten the day when a course in college algebra will not be found in any college curriculum. H. E. C.

Introduction to Botany, by J. Y. Bergen, and Otis W. Caldwell, Dean of University College, University of Chicago. Pages vii+368. 13x19.5 cm. Cloth. 1914. $1.15. Ginn & Company, Boston.

The book before us, like its predecessor, meets the demand for a high school text containing more than is usually given on applied sciences related to botany. There can be no doubt that these features bring pure botanical science nearer to the experience and interests of many young people and make the instruction more beneficial to the average high school pupil. It is a relief to find that the authors have done this and have, at the same time, given in an excellent manner as much of physiology, ecology, and classification as should be presented to the high school pupil.

The order of treatment is, on the whole, admirable. In the portion dealing with classification, the logical order from lowest to highest, from simple to more complex, has been followed. How much and what subject matter should precede this is a question about which botanists will probably never agree. Undoubtedly physiology forms an easy approach for the pupils, since a knowledge of human physiology is presupposed. On the other hand, this method requires a partial treatment of structure in one portion of the book and a completion of such studies in later chapters. Likewise this order leads to an almost complete omission of the physiology of lower plants in the portion of the text where physiology is made prominent. However, this neglect is made good, in large measure at least, in succeeding chapters. For many well prepared teachers, there is sufficient human interest connected with the study of lower plants so that it is safe to begin classification in logical order after a much shorter introduction. The reviewer believes that, with such teachers, the study of classification may begin much sooner, making possible more of the correlation so desirable in elementary treatment. However, a text must be adapted, in part at least, to the condition of preparation of the average teacher; and many teachers know little about lower plants.

The questions discussed above are proper ones to raise in the minds of teachers, but any order that can be devised must be more or less of a compromise and open to criticism. It is plain enough that the authors could readily defend their order of presentation, which the teacher who uses this text should follow in the main. However, the reviewer would, if using the text, present all the chapters that treat applied sciences together. This can be accomplished by giving chapters eight and twelve just before chapters nineteen and twenty.

The problems at the close of each chapter are well chosen, and the answers can seldom be derived directly from the text. They require, rather, a good amount of observation and reasoning on the part of the pupil, while no poorly prepared teacher can handle them successfully. Treatment of flowers as bisexual and unisexual is admitted by the authors to be inaccurate, and it also appears to the reviewer to be unnecessary. He hopes also that writers of texts will soon cease to treat lichens as dual organisms. However, this error detracts but slightly from a remarkably good treatment of lower plants. Teachers should be cautioned against allowing the introduction of a key and a flora to tempt them to make too much of plant analysis. Such work is relatively unimportant, though very interesting and in order to a limited extent under direct supervision.

As a whole, the text has no superior and few if any equals for the high school. It should appeal strongly to the best prepared teachers, whether the course covers a half year or a year. BRUCE FINK.

A Foundation Course in Chemistry for Students of Agriculture and Technology, by J. W. Dodgson, B. Sc. (Lond.), Lecturer in Chemistry at University College, Reading, and J. Alan Murray, B. Sc. (Edin.), Lecturer in Agricultural Chemistry at University College, Reading. With diagrams. Pages x+243. 13x19x1.8 cm. 212 questions. 34 examples. 1913. Price, $1.10 net. Longsman, Green & Co., London, New York.

Although designed as a preparatory course for students of agriculture and technology this little book might well find a place as the regular text in many high schools.

While forced to eliminate and to condense their materials, the authors have nevertheless included all that could well be handled by the average High School Junior in the time usually allotted to chemistry.

The presentation of the subject matter is excellent and the order of arrangement good. The contact that is kept between the chemistry and its applications might well be studied by those who would teach vocational chemistry as its aim is apparently to make the pupil intelligent in regard to the relation between chemistry and the affairs of daily life. F. B. W.

Hervorragende Leistungen der Technik, Erster Teil, by Prof. Dr. K. Schreber. Pages 216. 14x20 cm. Price M. 3.—. 1913. B. G. Teubner, Leipzig.

This is volume 20 of the Naturwissenschaftliche Schülerbibliothek, edited by Prof. Dr. Bastian Schmid. It discusses in a way that can be understood by non-technical readers some of the problems and achievements of engineers. The titles of the chapters are: I. Der Brückenbau. A. Die Festigkeit. B. Die graphische Statik. C. Die Kaiser-Wilhelm-Brucke. II. Wind- und Wasserkräfte. A. Kraft und Arbeit. B. Wind- und Wasserkraftmaschinen. C. Die Urfttalsperre. III. Wärmekraftmaschinen und Heizung. A. Die Wärme. B. Die Dampfmaschinen. C. Die Gasmaschine. E. Der Mensch als Kraftmaschine. E. Die Heizung.

There are fifty-six drawings and illustrations in the book. These three German books are a good example of the type of German books that should be placed in high school libraries. They give an opportunity for the pupils studying German to apply their knowledge in other departments, and also to gain a broader outlook in the fields of mathematics and science. H. E. C.

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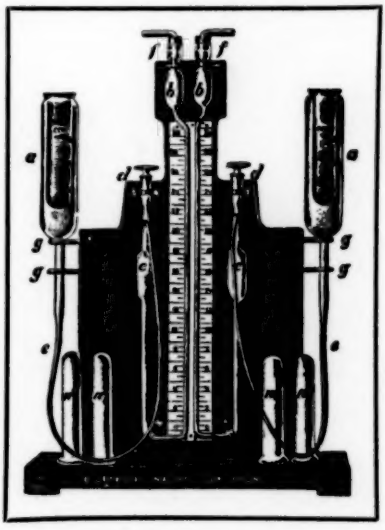

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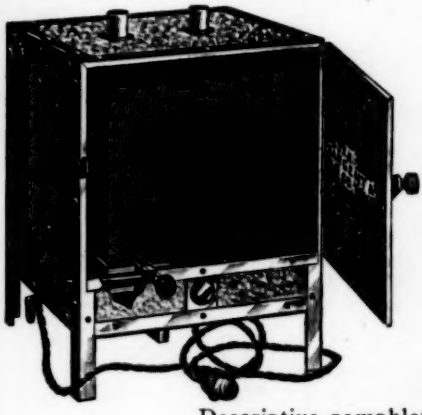

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